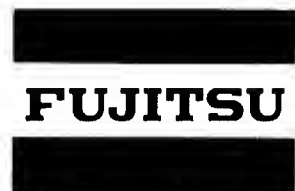


# M2351A/AF

## **Mini-Disk Drive**

## **Customer Engineering Manual**



| REVISION RECORD                    |                |                                                                                                                                                                                                  |
|------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Edition                            | Date Published | Revised contents                                                                                                                                                                                 |
| A                                  | Mar. 1, 1981   | First Edition                                                                                                                                                                                    |
| B                                  | Aug. 10, 1982  | Second Edition                                                                                                                                                                                   |
| C                                  | Jan., 1983     | Third Edition                                                                                                                                                                                    |
| D                                  | Apr., 1983     | Fourth Edition                                                                                                                                                                                   |
| D1                                 | Aug., 1983     | Fifth Edition                                                                                                                                                                                    |
| E                                  | Mar., 1984     | 1-1, 1-17, 2-8, 3-8, 3-19, 7-15, 8-6, 8-7 - 16, 13-6, 13-7, 17-12, 17-21, 17-27, 17-30, 17-33, 17-36, 17-38, 17-39, 17-43, 17-45, 17-48, 17-49, 17-68, 17-75 - 17-81, 17-83, 17-88, 17-90, 17-91 |
| E1                                 | Dec., 1984     | Sixth Edition                                                                                                                                                                                    |
|                                    |                |                                                                                                                                                                                                  |
| Specification No.: B03P-4655-0001A |                |                                                                                                                                                                                                  |

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## INTRODUCTION

This manual is for customer engineers who handle the new Mini-Disk Drive M2351A/AF. It describes how to operate, handle and maintain the drive.

This manual consists of the following seventeen chapters.

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| Chapter 2  | INSTALLATION                   |
| Chapter 3  | OPERATION AND CHECKOUT         |
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## CHAPTER 1 GENERAL INFORMATION

### 1.1 GENERAL DESCRIPTION

The M2351 Disk Drive is a compact state-of-the-art moving head disk drive with a storage capacity of up to 474 megabytes (unformatted) in a very compact package. It uses Winchester type heads and platters, allowing higher recording density, data transfer rate, and greater reliability, while offering a faster access time. The media is non-removable. This drive is appropriate for large capacity, high speed data storage in an online and/or batch system.

Model M2351A is of the Non-Fixed-Head type, and model M2351AF is of the Fixed-Head type with an unformatted fixed-head capacity of 1.69 megabytes to further improve the system throughput.

Higher cost/performance and improved reliability can be achieved in computer systems that utilize M2351 disk drives.

The drive is designed to meet the following standards:

1. UL478 Electronic Data Processing Unit and Systems.
2. CSA C22.2 No. 154-1975 Data Processing Equipment.

Note: 'Early version' denotes M2351A (- #1898) and 'Current version' denotes M2351A (#1899-). Regarding the M2351AF, all drives are 'Current version'.

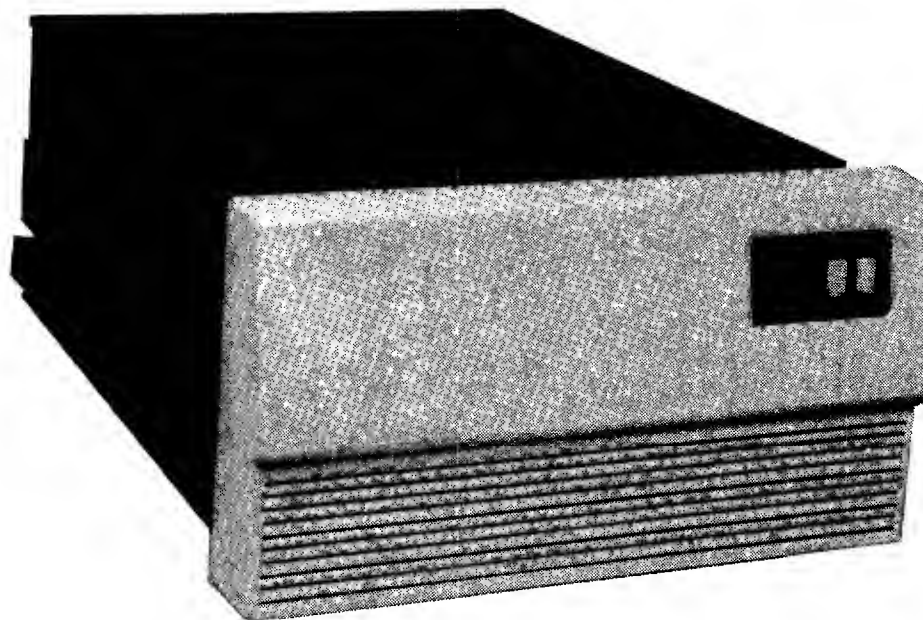


Fig. 1.1-1 External View of M2351A/AF

B03P-4655-0001A...E1

## 1.2 FEATURES

### (1) Large Capacity and High Performance

- 474 megabytes of unformatted data can be stored on six disks.
- The M2351 disk drive provides exceedingly high performance characteristics such as 1.859 megabytes per second data transfer, 18 milliseconds average access time, and 7.58 milliseconds average latency time.

### (2) Compact Size

The disk drive is a compact unit containing Disk Enclosure (DE), DC power supply and circuit boards, is designed for mounting in a standard 19-inch rack.

### (3) High Reliability

The disk enclosure includes a rotary actuator, a direct-drive spindle motor, the magnetic heads, disks and carriage. A completely sealed self-contained airflow system is used within the DE to assure a clean environment for low-flying heads, thus ensuring very high reliability.

### (4) High Serviceability

- The drive is modular in construction. All major subassemblies are easily removed/replaced in the field.
- Serviceability is further improved by diagnostic information provided on the maintenance-aid display and/or sense information provided by the interface signals.

### (5) Maintenance-free

The M2351 disk drive requires substantially reduced maintenance because of the completely sealed DE, a direct-drive DC Spindle motor and highly reliable printed circuit boards.

### (6) Other Features

- High recording density with state-of-the-art technology  
A recording density of more than  $10^7$  bits per square inch is achieved with the advanced head and disk.

– Low power consumption

Less than 0.62 KVA is required despite the large storage capacity.

– Fixed-head model

The M2351AF has a fixed-head area of 1.69 megabytes (unformatted) capacity. The data in this area can be accessed without positioning time delay but with only latency time delay, thus providing high system throughput.

– Dual channel feature

This option permits two controllers to access the same disk drive, allowing the drive to be shared by two systems.

– Modified SMD Interface

The interface between the controller and the disk drive is modified from the standard SMD interface to provide higher track capacity and higher maintainability.

The following are the major modified items.

- (1) Data Transfer rate
- (2) Track capacity
- (3) Timing of Read/Write operation
- (4) Addition of Tag 4 and Tag 5



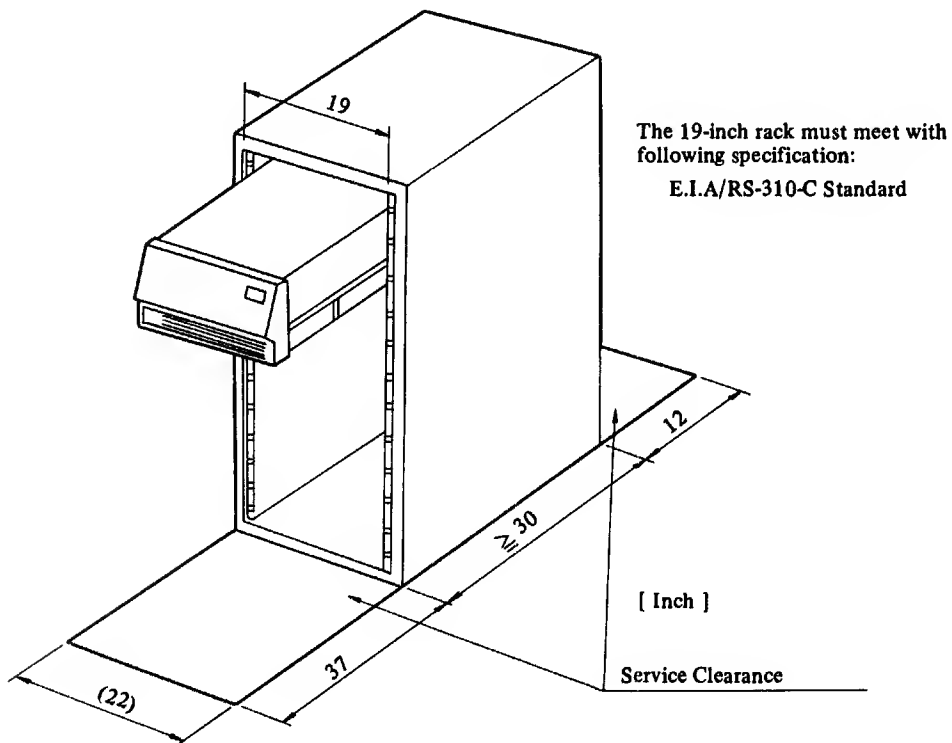
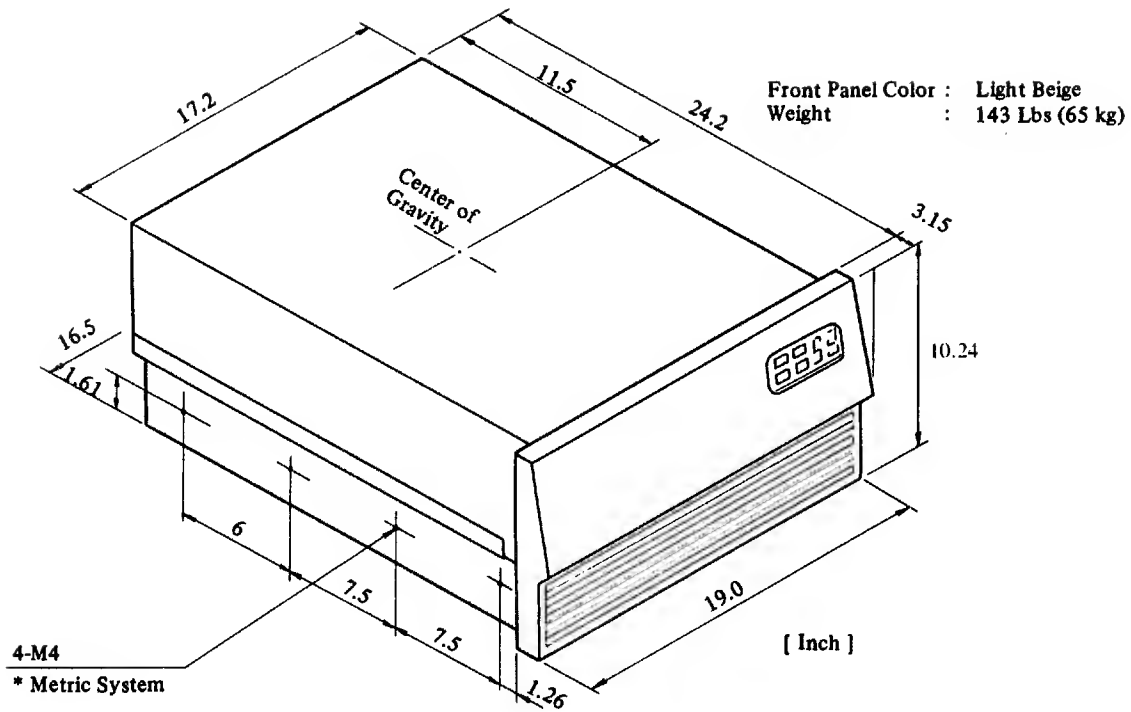


Fig. 1.1-2 Physical Dimensions

### 1.3 PERFORMANCE SPECIFICATIONS

Table 1.3-1 Specifications of M2351A/AF

|                                  |                 |                                                                                                                                                                                            |
|----------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Capacity                         | /Drive (MB)     | 474.2 (Unformatted)                                                                                                                                                                        |
|                                  | /Track (KB)     | 28.160 (Unformatted)                                                                                                                                                                       |
| Configuration of Disks and Heads |                 | <p>Fixed heads</p> <p>6 19 18</p> <p>5 17 16</p> <p>4 15 14</p> <p>3 13 12</p> <p>2 11 10</p> <p>1 9 8</p> <p>7 6</p> <p>5 4</p> <p>3 2</p> <p>1 0</p> <p>Data heads</p> <p>Servo head</p> |
| Fixed Head<br>(M2351AF Only)     | Tracks          | 60 (3 Cylinders)                                                                                                                                                                           |
|                                  | Capacity (MB)   | 1.69 (Unformatted)                                                                                                                                                                         |
| Rotational Speed (RPM)           |                 | 3,961                                                                                                                                                                                      |
| Latency (ms)                     |                 | 7.5                                                                                                                                                                                        |
| Disk                             | Diameter (Inch) | 10.5                                                                                                                                                                                       |
|                                  | Number          | 6                                                                                                                                                                                          |
| Heads                            | /Drive          | 20 + 1 (Servo)                                                                                                                                                                             |
|                                  | /Surface        | 2                                                                                                                                                                                          |
| Cylinders                        |                 | 842                                                                                                                                                                                        |
| Data Transfer Rate (MB/sec)      |                 | 1.859                                                                                                                                                                                      |
| Positioning Time<br>(ms)         | Maximum         | 35                                                                                                                                                                                         |
|                                  | Average         | 18                                                                                                                                                                                         |
|                                  | Minimum         | 5.5                                                                                                                                                                                        |
| Track Density (TPI)              |                 | 880                                                                                                                                                                                        |
| Bit Density (BPI)                |                 | 12,800                                                                                                                                                                                     |
| Data Coding                      | on interface    | NRZ                                                                                                                                                                                        |
|                                  | on disk surface | MFM                                                                                                                                                                                        |

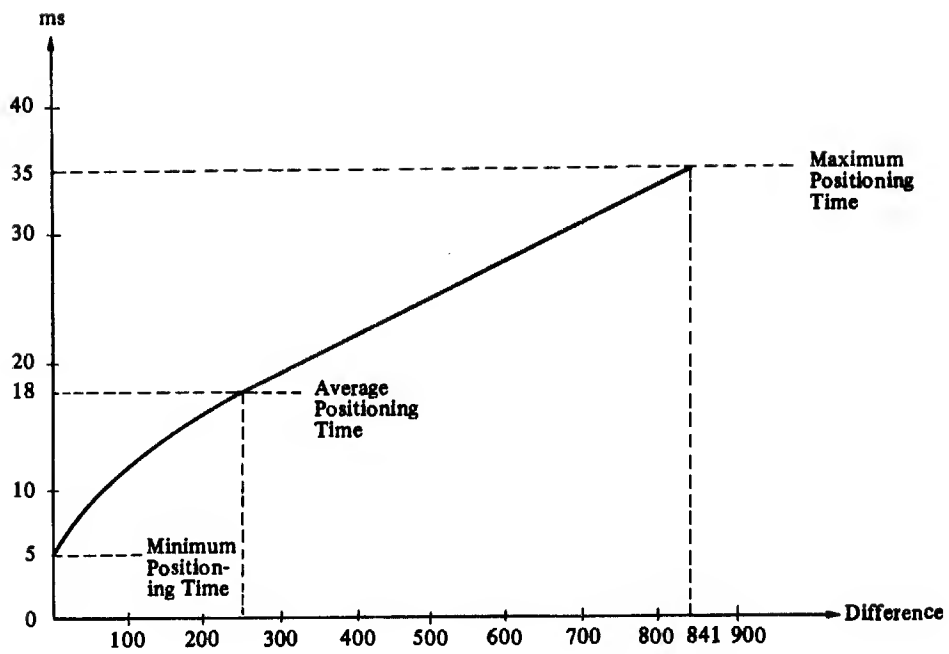


Fig. 1.3-1 Positioning Time vs. Difference

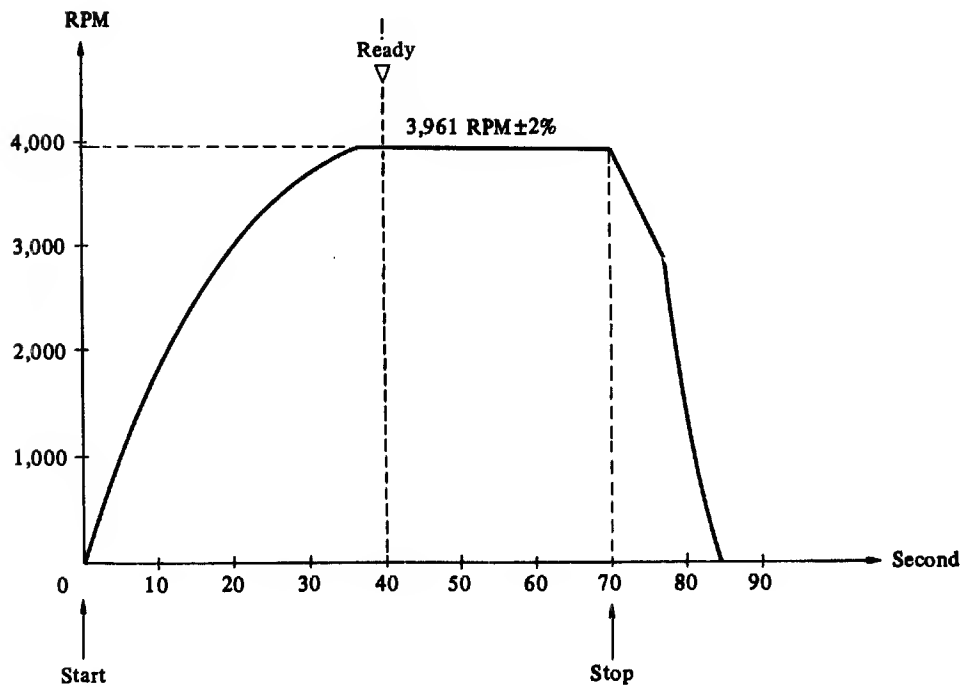


Fig. 1.3-2 Spindle Start/Stop Time

# 1.4 ENVIRONMENTAL SPECIFICATIONS

Table 1.4-1 Environmental Requirements

| Environment  | Storage or transmit<br>in packaged form                                   |                                                                         | On Site<br>Non-Operating                                                | Operating<br>Office<br>Environment                                      |
|--------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Temperature* | Within 24<br>Hours                                                        | More than 24<br>Hours                                                   | 23°F ~ 140°F<br>(-5°C ~ 60°C)<br>Max change<br>18°F/Hour<br>(10°C/Hour) | 50°F ~ 104°F<br>(10°C ~ 40°C)<br>Max change<br>18°F/Hour<br>(10°C/Hour) |
|              | -40°F ~ 140°F<br>(-40°C ~ 60°C)<br>Max change<br>36°F/Hour<br>(20°C/Hour) | 23°F ~ 140°F<br>(-5°C ~ 60°C)<br>Max change<br>18°F/Hour<br>(10°C/Hour) |                                                                         |                                                                         |
| Humidity     | 5% ~ 95% RH<br>Non-condensing                                             |                                                                         | 20% ~ 80% RH<br>Max change 10%/Hour<br>Non-condensing                   |                                                                         |
| Vibration    | 3G (When locked for<br>shipment)                                          |                                                                         | 0.2G<br>(10Hz ~ 500Hz)                                                  | 0.2G<br>(5Hz ~ 50Hz)<br>1G<br>(50Hz ~ 500Hz)                            |
| Shock        | 5G (Max. 30 ms)                                                           |                                                                         | 3G (Max. 10ms)                                                          | 2G (Max. 10ms)                                                          |
| Altitude     | 40,000 FT (12,000 m)                                                      |                                                                         | 10,000 FT (3,000 m)                                                     |                                                                         |
| Dust         | 0.168 mg/m <sup>3</sup> (Stearic Acid Standard)                           |                                                                         |                                                                         |                                                                         |
| Air flow     | —————                                                                     |                                                                         |                                                                         | 2.5 m <sup>3</sup> /min.                                                |
| Acoustic     | —————                                                                     |                                                                         |                                                                         | 60 dBA                                                                  |

$$* \text{ }^{\circ}\text{C} = \frac{5}{9}(\text{ }^{\circ}\text{F}-32)$$

## 1.5 POWER SPECIFICATIONS

Table 1.5-1 Power Requirements (Typical Values)

| Voltage<br>(Vac±10%) | Frequency<br>(Hz±2Hz) | Current (Aac) |         | Power Consumption<br>(KVA) | Heat Dissipation |              |
|----------------------|-----------------------|---------------|---------|----------------------------|------------------|--------------|
|                      |                       | Starting*     | Running |                            | (K•Cal/<br>Hour) | BTU/<br>Hour |
| 100                  | 50/60                 |               | 5.7/5.4 | 0.57/0.54                  | 460/420          | 1,800/1,600  |
| 120                  | 60                    | 5.3           | 4.6     | 0.55                       | 430              | 1,700        |
| 220                  | 50                    |               | 2.8     | 0.62                       | 510              | 2,000        |
| 240                  | 50                    |               | 2.6     | 0.62                       | 510              | 2,000        |

\* Worst case transient with a maximum of 40 amps for less than 1/2 cycle of input AC Power.

Refer to Figure 1.5-1.

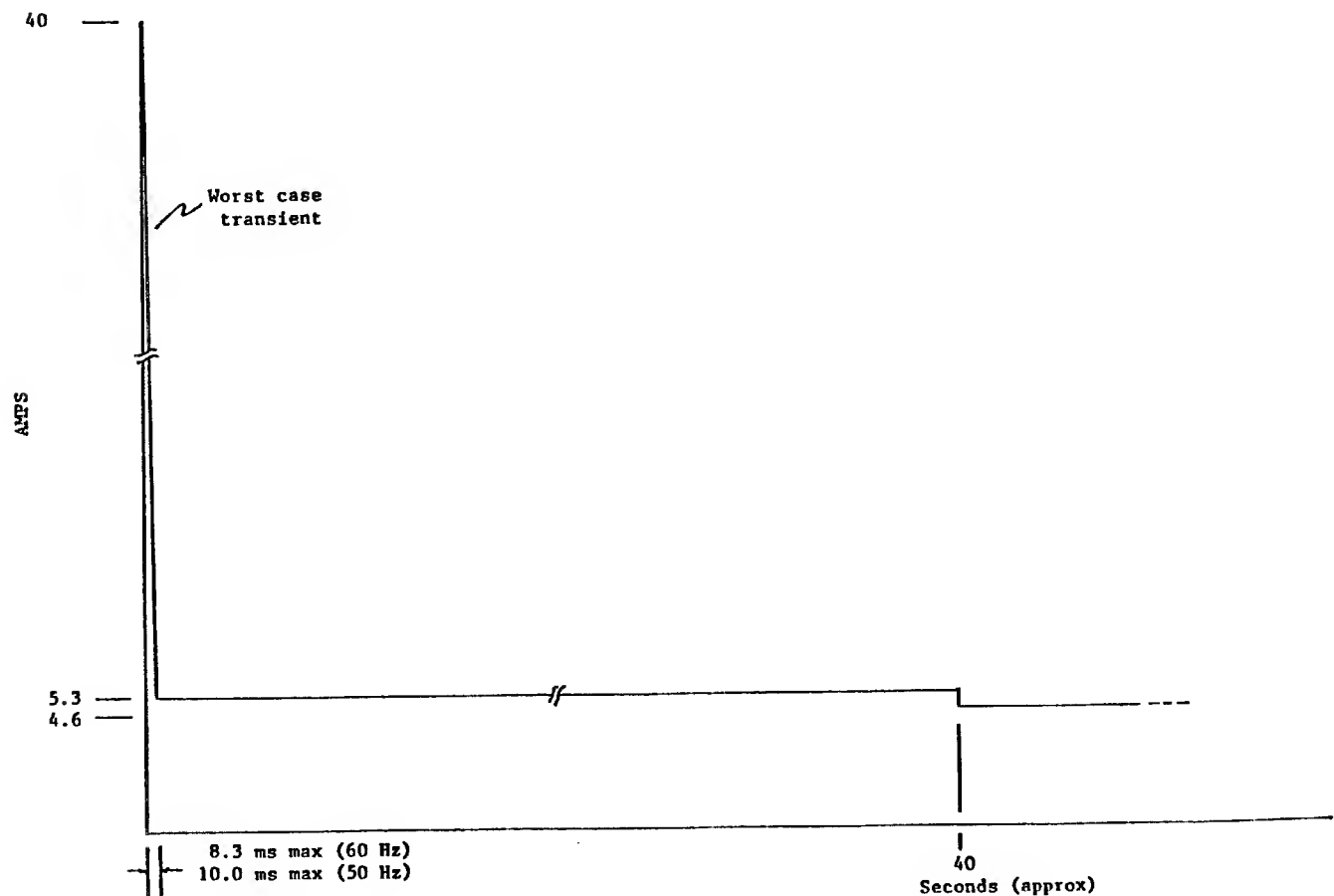


Fig. 1.5-1 AC START/RUN CURRENT CURVE M2351A

## 1.6 CABLE AND CONNECTOR SPECIFICATIONS

Table 1.6-1 Cables and Connectors

|                      | Cable                                               |                                | Connector (Supplier)        |                             |
|----------------------|-----------------------------------------------------|--------------------------------|-----------------------------|-----------------------------|
|                      | Specification                                       | Supplier                       | Drive Side                  | Cable Side                  |
| A-Cable<br>(60-Pin)  | Zo = 100±10Ω<br>28 AWG<br>7 Strands<br>100 FT. Max. | SPECTRA<br>STRIP<br>455-248-60 | FUJITSU<br>FCN-704P060-AU/L | FUJITSU<br>FCN-707J060-AU/B |
|                      |                                                     |                                | 3M<br>3472-2303             | 3M<br>3334-6010             |
| B-Cable<br>(26-Pin)  | Zo = 100±10Ω<br>28 AWG<br>7 Strands<br>50 FT. Max.  | ANSLEY<br>174-26               | FUJITSU<br>FCN-705P026-AU/L | FUJITSU<br>FCN-707J026-AU/B |
|                      |                                                     |                                | 3M<br>3429-1303             | 3M<br>3399-6010             |
| Power<br>Cable A     | See Figure 1.6-1                                    |                                |                             |                             |
| Power<br>Cable B     | See Figure 1.6-2                                    |                                |                             |                             |
| Power<br>Cable C ~ D | See Figure 1.6-3                                    |                                |                             |                             |

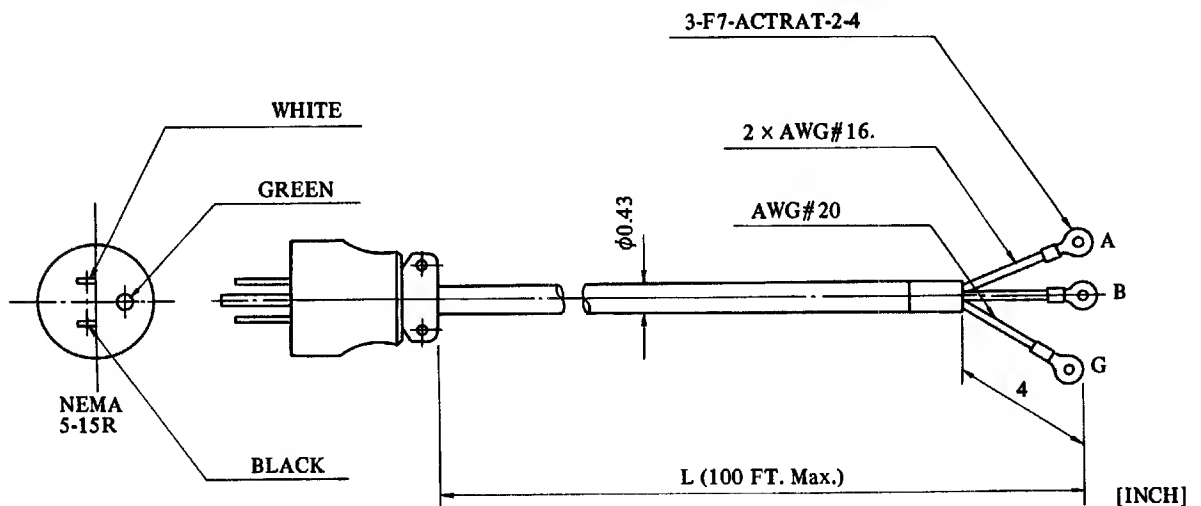


Fig. 1.6-1 Power Cable A

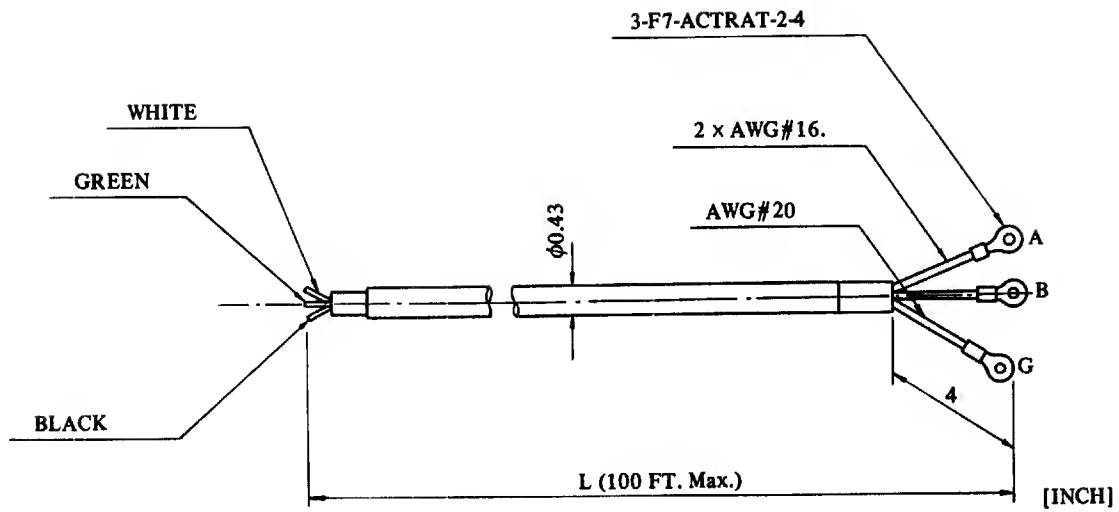


Fig. 1.6-2 Power Cable B

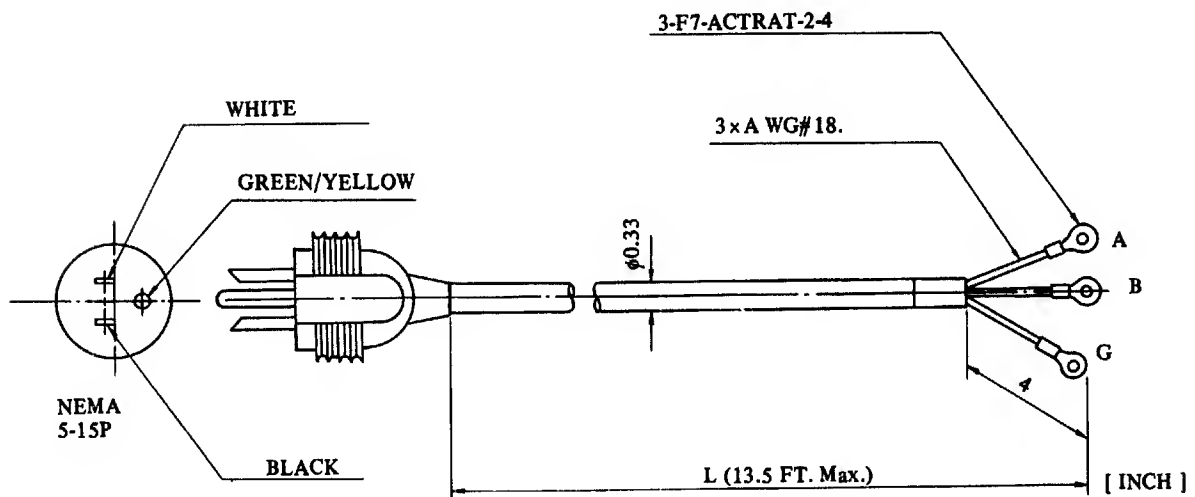


Fig. 1.6-3 Power Cable C ~ D

## 1.7 OPTIONS

Table 1.7-1 Option List

| No. | Name                    | Specification          | Remark                                                                                 |                                                                      |
|-----|-------------------------|------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| 1   | A-Cable                 | B660-1065-T006A        | Non-shield                                                                             | Cable length can be specified from 0.5 m to 30 m in 0.5 m increments |
| 2   |                         | B660-1954-T904A        | Shield                                                                                 |                                                                      |
| 3   | B-Cable                 | B660-1065-T008A        | Non-shield                                                                             | Cable length can be specified from 0.5 m to 15 m in 0.5 m increments |
| 4   |                         | B660-1954-T903A        | Shield                                                                                 |                                                                      |
| 5   | Power Cable A (UL only) | B660-1055-T027A        | Cable length can be specified from 1 m to 30 m in 0.5 m increments. (100/120 Vac only) |                                                                      |
| 6   | Power Cable B (UL, CSA) | B660-0620-T387A        | Cable length can be specified from 1 m to 30 m in 0.5 m increments. (220/240 Vac only) |                                                                      |
| 7   | Power Cable C (UL, CSA) | B660-1055-T033A        | L = 2.5 m, (100/120 Vac only)                                                          |                                                                      |
| 8   | Power Cable D (UL, CSA) | B660-1055-T034A        | L = 3.5 m, (100/120 Vac only)                                                          |                                                                      |
| 9   | Power Cable E (UL, CSA) | B660-1055-T035A        | L = 4.5 m, (100/120 Vac only)                                                          |                                                                      |
| 10  | Line Terminator (TCAMU) | B16B-4870-0010A#U      | Note that two line terminators are required in dual channel system.                    |                                                                      |
| 11  | Dual Channel Option     | B03B-4655-0100A        |                                                                                        |                                                                      |
| 12  | Slide Guide Option      | B030-4655-V100A        |                                                                                        |                                                                      |
| 13  | Front Panel Option      | B210-1435-X012A        |                                                                                        |                                                                      |
| 14  | Operator Panel Assembly | N860-3346-T001         |                                                                                        |                                                                      |
| 15  | Hour Meter              | B61L-0140-0011A #10000 | 10,000 hours                                                                           |                                                                      |



Note that the Fixed-Head is not an option but a model change from the Non Fixed-Head drive.

Non Fixed-Head Drive; M2351A (B03B-4655-B002A)

Fixed Head Drive ; M2351AF (B03B-4655-B003A)

When M2351A or M2351AF is ordered alone, it does not include the front panel, operator panel, etc. listed in Table 1.7-1.

A-, B- and Power Cable A, B length must be specified by adding comment behind the cable specification.

Example: B660-1065-T006A #10.5 m (A-Cable, 10.5 meters)

# 1.8 SPARE PARTS

Table 1.8-1 Recommended Spare Parts List

| No. | Name                    | Specification           | Quantity |     | MTBF<br>(K-hours) |   |   | Remarks                                    |                                          |
|-----|-------------------------|-------------------------|----------|-----|-------------------|---|---|--------------------------------------------|------------------------------------------|
|     |                         |                         | A        | AF  |                   |   |   |                                            |                                          |
| 1   | DE Assembly             | B030-4610-T005A         | 1        | —   | 60                |   |   | Non-fixed<br>heads type                    | M2351A<br>(#1~#1898)                     |
|     | DE Assembly             | B030-4610-T007A         | 1        | —   | 60                |   |   |                                            | M2351A<br>(#1899~)                       |
| 2   | DE Assembly             | B030-4610-T006A         | —        | 1   | 60                |   |   | Fixed<br>heads type                        | —                                        |
|     | DE Assembly             | B030-4610-T008A         | —        | 1   | 60                |   |   |                                            | M2351AF<br>(#1~)                         |
| 3   | DC Power Supply         | B14L-5105-0073A         | 1        | 1   | 200               |   |   |                                            |                                          |
| 4   | Line Blower             | B90L-1200-0101A         | 1        | 1   | 400               | — | — |                                            |                                          |
| 5   | Operator Panel Assembly | N860-3346-T001          | 1        | 1   | 400               |   |   |                                            |                                          |
| 6   | PCB TVH MU              | B16B-8130-0010A#U       | 1        | 1   | 360               |   |   | Power<br>Amplifier                         | M2351A<br>(#1~#1898)<br>M2351AF<br>( — ) |
|     | PCB TVK MU              | B16B-8800-0010A#U       | 1        | 1   | 360               |   |   |                                            | M2351A<br>(#1899~)<br>M2351AF<br>(#1~)   |
| 7   | PCB RFJ AU              | C16B-5500-0990#U        | 1        | 1   | 220               |   |   | Read Amplifier                             |                                          |
| 8   | PCB SVI AU              | C16B-5501-0010#U        | 1        | 1   | 180               |   |   | Servo Circuit                              |                                          |
| 9   | PCB 512398              | C16B-5123-0980#U        | 1        | 1   | 420               |   |   | Logic Circuit                              |                                          |
| 10  | PCB DQ EMU              | B16B-8140-0010A#U       | 1        | 1   | 500               |   |   | Interface Circuit                          |                                          |
| 11  | PCB HG AMU              | B16B-7830-0010A#U       | 1        | 1   | 1660              |   |   | Indicator Unit                             |                                          |
| 12  | PCB BQ GMU              | B16B-8160-0010A#U       | 1        | 1   | 1440              |   |   | Back Panel                                 |                                          |
| 13  | PCB DQ FMU              | B16B-8150-0010A#U       | (1)      | (1) | 400               |   |   | Interface Circuit<br>(Dual Channel Option) |                                          |
| 14  | Air Filter              | B90L-0400-0303A         | 1        | 1   | —                 | — | — |                                            |                                          |
| 15  | Fuse                    | C60L-0020-0001<br>#MP05 | 1        | 1   | —                 | — | — | Used in DC Power Supply<br>(0.5 A)         |                                          |

Notes: MTBF; Mean Time Between Failures (K•hours)

## 1.9 MAINTENANCE TOOLS AND EQUIPMENT

Table 1.9-1 Maintenance Tools and Equipment

| No. | Tools and Equipment      | Specification                  | Remark               |
|-----|--------------------------|--------------------------------|----------------------|
| 1   | Extension Cable          | B660-1060-T072A#L510R0         | 20 pins              |
| 2   | Extension Cable          | B660-1060-T074A#L510R0         | 50 pins (2 required) |
| 3   | Extension Unit           | C960-0030-T029                 |                      |
| 4   | Extractor                | C960-0300-T001                 | One required         |
| 5   | Oscilloscope             | TEKTRONIX 475, or equivalent   |                      |
| 6   | Oscilloscope Probe (X10) | TEKTRONIX P6053B or equivalent |                      |
| 7   | Digital Multimeter       |                                |                      |
| 8   | Screwdriver              | #2 Phillips                    |                      |
| 9   | Hexagonal Wrenches       | 6 MM                           | Metric system        |
| 10  |                          |                                |                      |
| 11  |                          |                                |                      |
| 12  |                          |                                |                      |
| 13  |                          |                                |                      |

## 1.10 RELIABILITY AND SERVICE GOALS

### (1) MTBF

MTBF is defined as follows.

$MTBF = \text{operating time} / \text{the number of failures encountered}.$

Operating time is the total time duration during which the power is ON except during maintenance work. Failure is defined as a malfunction that requires either repairs, adjustments, or replacement. Mishandling by the operator, power failure, control unit trouble, cable trouble and trouble due to improper environmental conditions are not included.

The MTBF of M2351A/M2351AF is more than 20,000 hours estimated value after an initial period of 200 hours.

### (2) MTTR

MTTR is the average time a trained service mechanic should take to diagnose and repair the failure. The M2351A/M2351AF are designed for an MTTR of 30 minutes or less.

### (3) Preventive Maintenance Time

The front panel air filter should be cleaned or replaced at one year intervals, or as required.

### (4) Component Life

M2351A/M2351AF need not be overhauled for the five first years.

### (5) Power Loss

If AC power to the unit is lost, data stored in the disk is preserved. However, if the power failure occurs during a WRITE operation, that data is not guaranteed.

(6) Read Error

Prior to determination of the read error rate, the data must be verified as correctly written and all identified media defects must be deallocated or skipped.

- Recoverable Error Rate .....  $10 \times 10^{-11}$

While reading  $10^{11}$  bits of data, less than 10 read errors would be encountered which are recoverable in 4 retries without using the ECC functions and the offset operation.

- Unrecoverable Error Rate ...  $10 \times 10^{-14}$

While reading  $10^{14}$  bits of data, less than 10 read errors would be encountered which are unrecoverable in 5 retries without using the ECC function.

Retry routine; after 4 times of re-reading with and without offset, RTZ must be performed.

(7) Seek Error Rate .....  $1 \times 10^{-7}$

(8) Quality Standards of Media at Shipment (Summary)

- The number of defects per DE shall not exceed 500.

- The number of defective tracks per DE shall not exceed 30.

(A track containing two or more defects is defined as a defective track.)

- Head 0 and 1 at cylinder 0 should be perfect tracks.

Refer to Chapter 6.3 for detail.



## CHAPTER 2    INSTALLATION

### 2.1    STORAGE

When the drive is stored for a prolonged period, avoid locations where the environment is extreme. Stored units should be properly packed and can be stored stacked vertically, two high. When the temperature difference between storage (or shipping) and the unpacking environment exceeds 20°C (36°F), the unit should be allowed to remain in packaged form for more than 3 hours to avoid condensation when unpacking.

### 2.2    UNPACKING

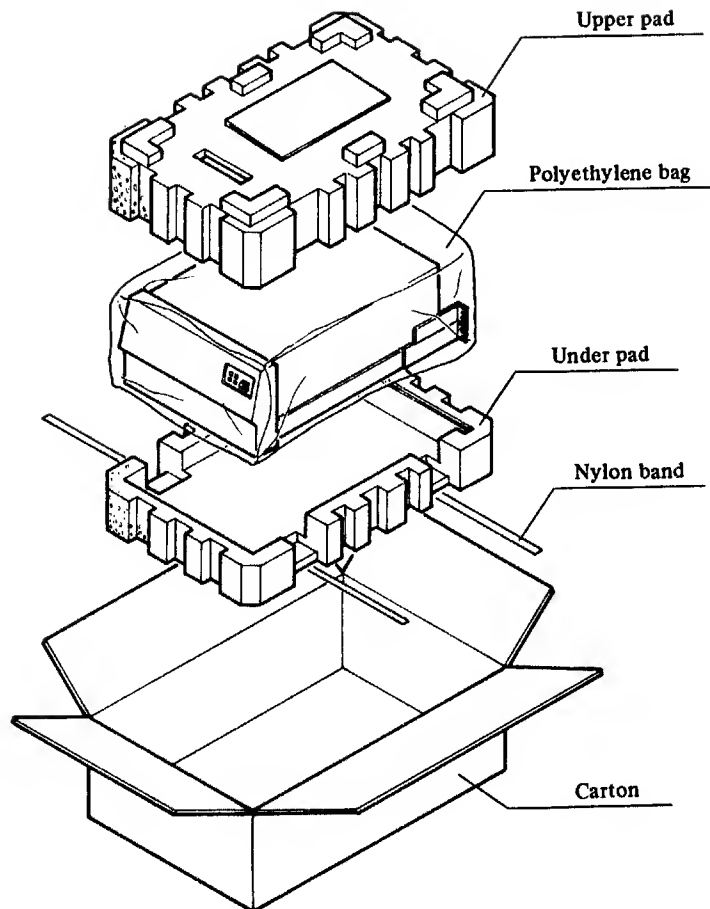
- (1) The M2351 is shipped in a carton surrounded by shock absorber as shown in Figure 2.2-1. (Note: the shipping carton is intended to be reuseable.) To unpack the unit, first the carton flaps to the left and right and then take out the unit. Do not grasp the front panel or cover of the unit to lift - use the sub-frame at the bottom to avoid the possibility of sub-assembly damage. Take care to move the unit carefully to avoid abrupt impact or shock.
- (2) After unpacking the drive, check for scratches or dents. Remove the cover, (Figure 2.2-2) and visually inspect inside the drive as follows:
  - (a) Check for loose or missing parts, or foreign matter.
  - (b) Check that the PCB's are properly seated in the correct positions.
  - (c) Check that all connectors are secure and no cable chafing damage has occurred.

After inspection, (prior to operating the drive), unlock the rotary actuator and secure in the unlocked position. (Refer to Figure 2.3-1) And then, lift the card cage vertically rotate over the side. Remove the vibration preventive block under the DE housing.

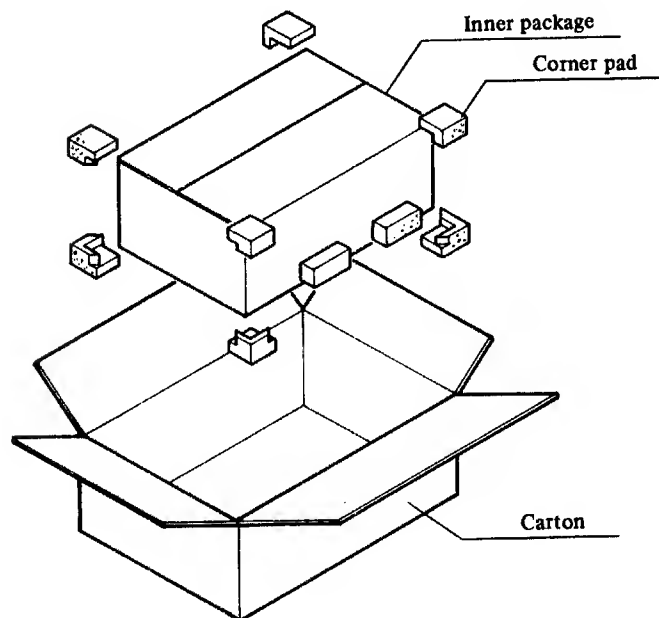
#### (3)    Packing

Prior to packing the drive, insure that the rotary actuator locking mechanism is secured in the locking position, (Refer to Figure 2.3-1) and the vibration preventive block properly inserted under the DE housing (Refer to Figure 2.2-2). When reshipping the drive, place it in a polyethelene bag and repack it in the Original carton with shock absorbers. (Refer to Figure 2.2-1)



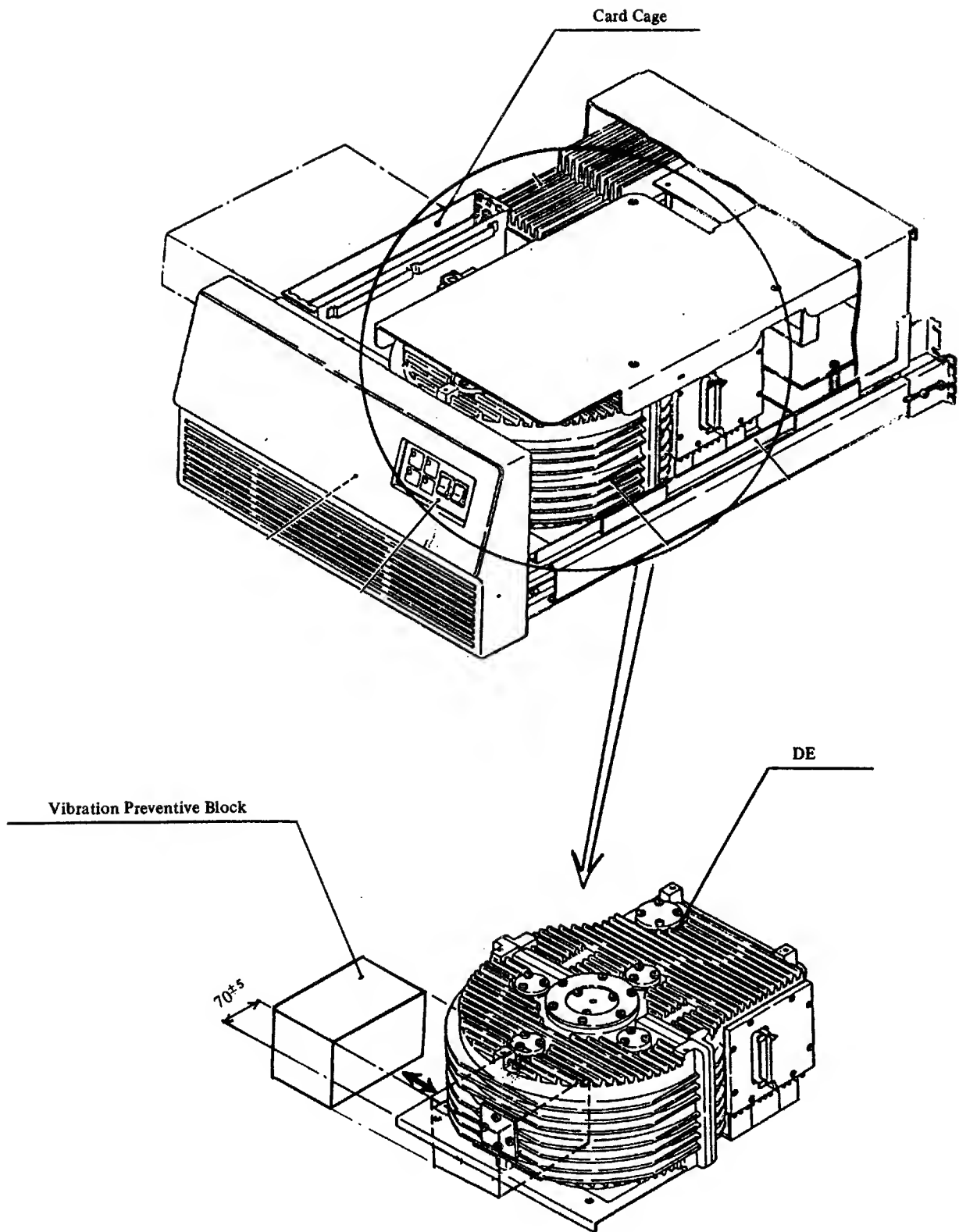


(a) Inner packaging



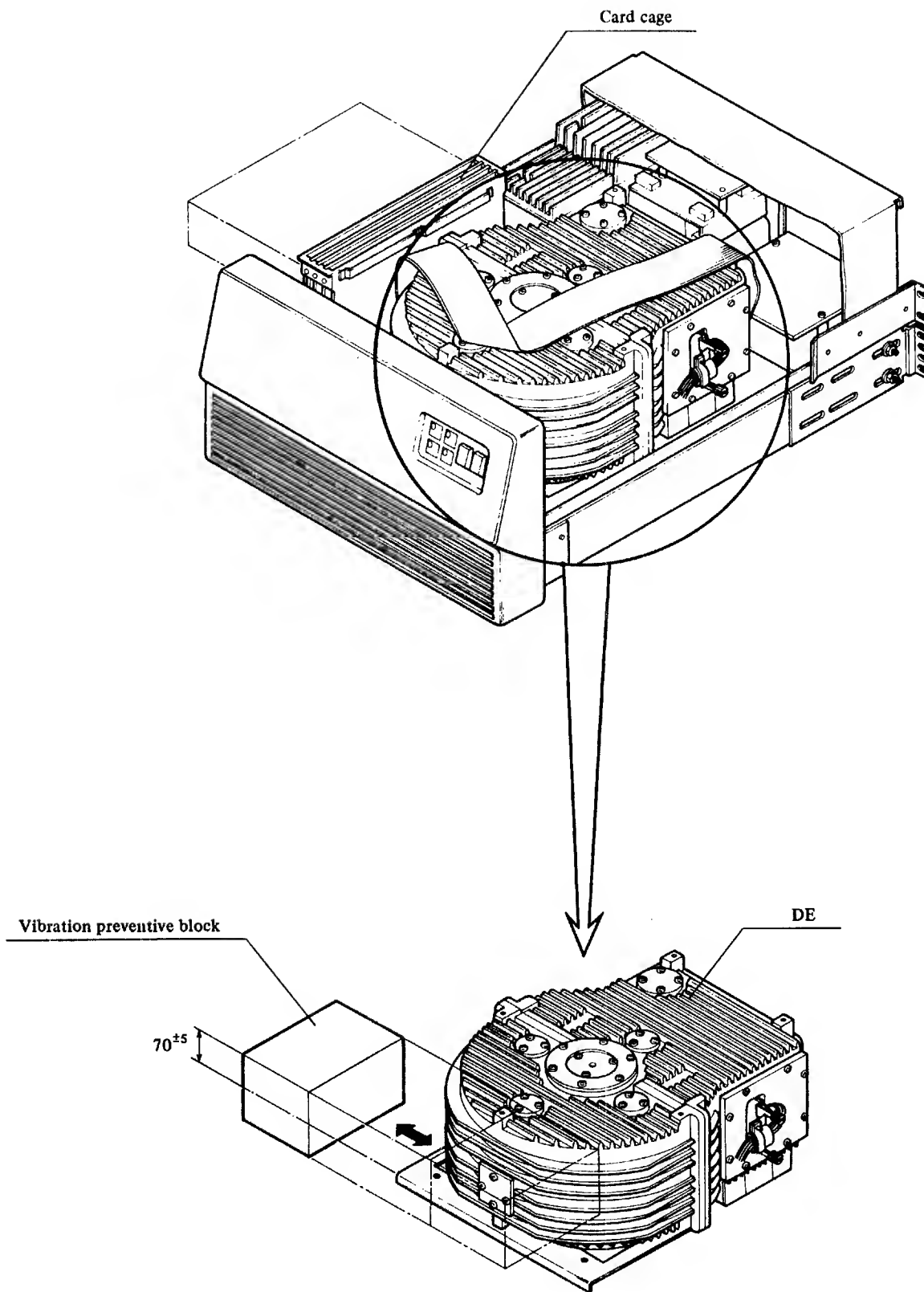
(b) Outer packaging

Figure 2.2-1 Exterior View and Construction of Carton



(a) Early version

Figure 2.2-2 Cover Removal



(b) Current version

Figure 2.2-2 - Continued

### 2.3 ROTARY ACTUATOR UNLOCKING/LOCKING

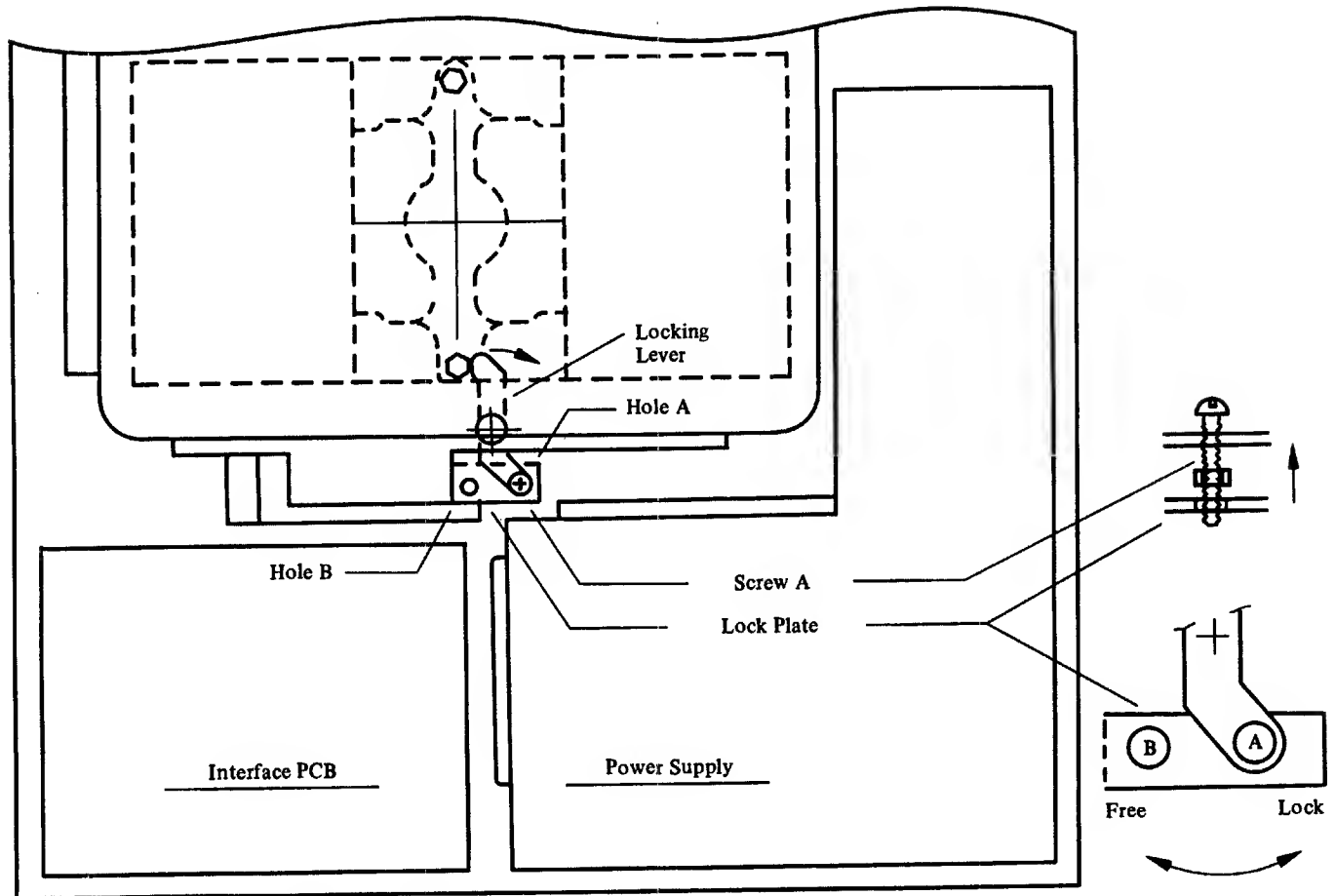


Figure 2.3-1 Rotary Actuator Unlocking/Locking  
(Top View)

This mechanism can be readily viewed from the rear of the drive by looking over the Interface PCB.

#### (1) Unlocking

Loosen Screw A (by means of a phillips screwdriver, 8 inches or longer), sufficiently to free the screw tip from the hole in the Lock Plate. With the screwdriver, rotate the Locking Lever to the Unlocked position (Hole B), and secure in that position by gently tightening Screw A. (Refer to Figure 2.3-1)

## (2) Locking

Loosen Screw A (by means of a phillips screwdriver, 8 inches or longer), sufficiently to free the screw tip from the hole in the Lock Plate. With the screwdriver, rotate the Locking Lever to the Locked position (Hole A), and secure in that position by gently tightening Screw A. (Refer to Figure 2.3-1)

## 2.4 SLIDE/MOUNTING INSTRUCTIONS

The drive can be slide-mounted in a standard 19-inch rack or built into a system cabinet. Installation procedures follow, and are illustrated in Figure 2.4-1.

### (1) Slide Rail Installation and Mounting

- a. Extend the slide guide and release from slide rail.
- b. Install the slide guide (as shown) in the 19-inch rack or cabinet.
- c. With both the slide guides installed and extended, lift the drive (with slide rails already attached) onto the extended guides. Be sure the rail is correctly seated and latched in the guide.

NOTE: The drive weight approximately 143 lbs (65 kg), and requires at least two people to install.

### (2) Drive Removal

- a. Fully extend the drive from the rack. Release the latching mechanism and, with a lifting-forward motion, lift the drive off the slide guides.

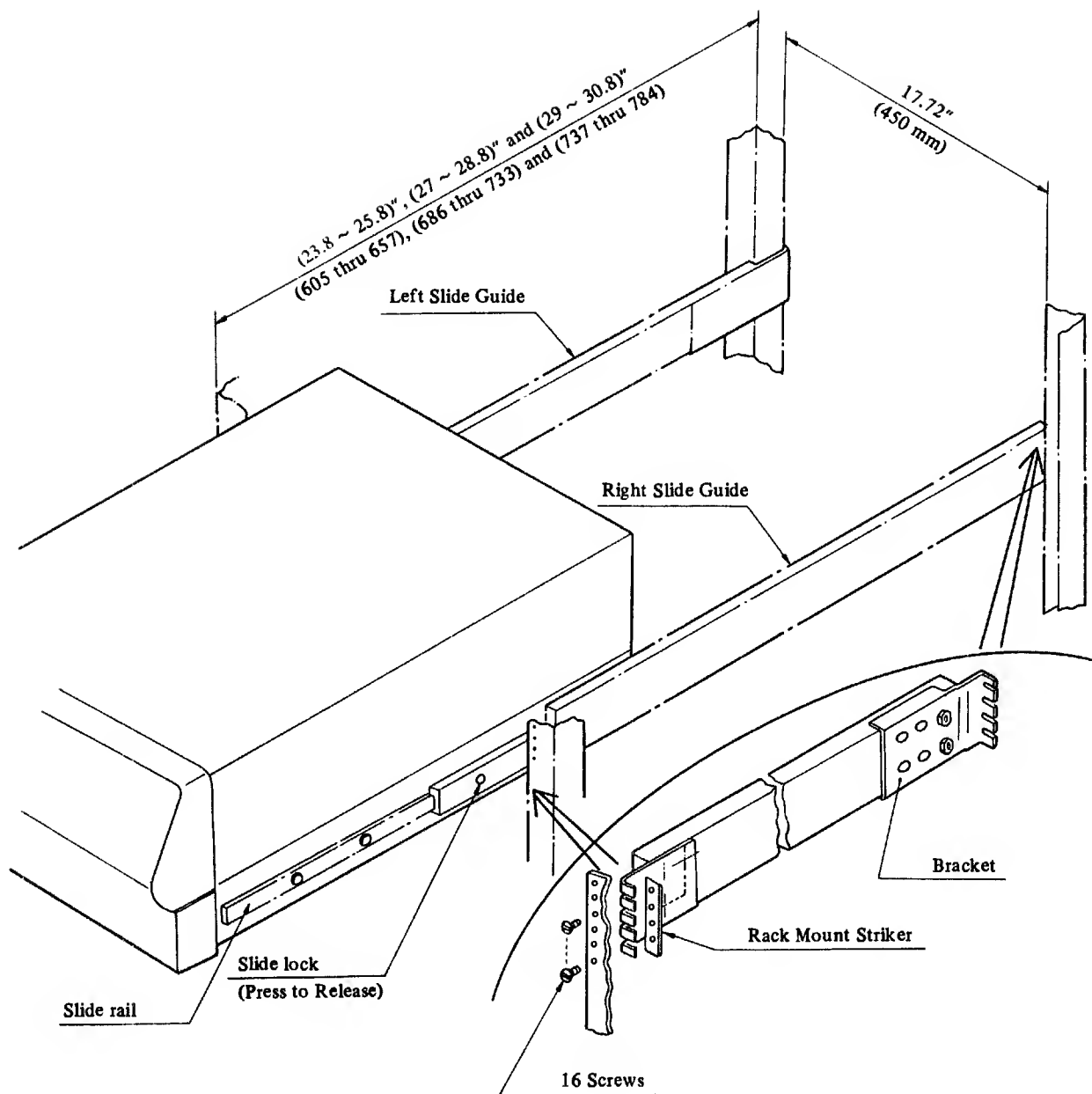


Figure 2.4-1 Rack Mount Installation

## CHAPTER 3 OPERATION AND CHECKOUT

### 3.1 DC POWER SUPPLY UNIT

Control panel of the DC power supply unit is shown in Figure 3.1-1.

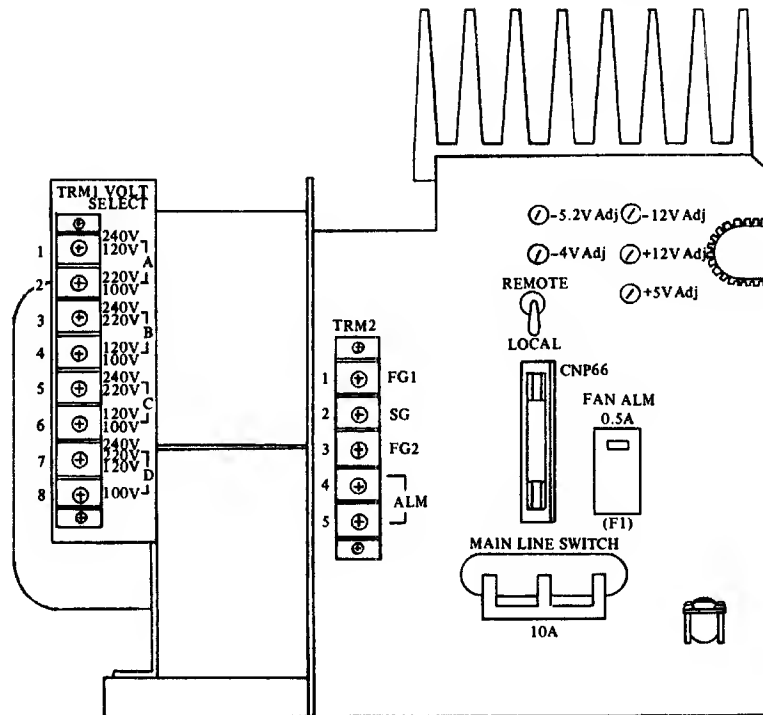


Figure 3.1-1 Control Panel of DC Power Supply Unit

#### (1) Main Line Switch (Non-Fuse Breaker)

Supplies AC power to the unit. If any of following failures occurs, the breaker is tripped.

- Over current in the AC input
- Over current or voltage in the DC output
- Fan (Line-Blower) Alarm
- Over Temperature of the heat sink or of the transformer in the DC power supply unit.

#### (2) Fan ALM (Fuse)

Indicates failure of the line-blower.

#### (3) Remote/Local (Switch)

When this is set to Remote, the spindle motor starts/stops rotating in accordance



with the commands (Power Sequence Pick/Hold) issued from the controller in conjunction with the operator panel start switch. When set to Local, rotation is controlled solely by the Start switch on the operator panel.

#### (4) TRM 1 (Terminal)

The taps on this terminal must be changed in accordance with the voltage and frequency of AC input power, as shown in Table 3.1-1

Table 3.1-1 Tap Number to be shortened

| Vac (Hz)    | Tap Number |           |
|-------------|------------|-----------|
|             | (A) - (B)  | (C) - (D) |
| 100 (50/60) | 2 - 4      | 6 - 8     |
| 120 (60)    | 1 - 4      | 6 - 7     |
| 200         | 2 - 3      | 5 - 8     |
| 220 (50)    | 2 - 3      | 5 - 7     |
| 240 (50)    | 1 - 3      | 5 - 7     |

#### (5) TRM 2 (Terminal)

FG1 ..... Frame Ground

SG ..... Signal Ground

FG2 ..... Frame Ground with a 510 k $\Omega$  resistor

ALM ..... Alarm Output (not used)

The Frame Ground and Signal Ground are completely isolated in the drive, and they are provided as FG1/FG2 and SG on this terminal.

As shown in Figure 3.1-2, FG1 is a frame ground itself, but FG2 is a frame ground to which a 510 k $\Omega$  resistor is provided in DC Power Supply.

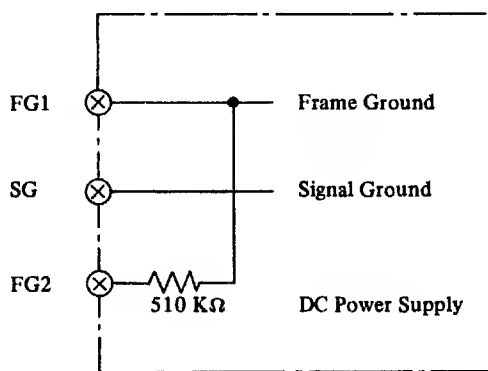


Figure 3.1-2 FG1/FG2 and SG

At the time of shipment, SG and FG2 are connected with a shorting plate.

Refer to Chapter 4.3 on the operation.

#### (6) Volt ADJ (Variable Resistors)

Although adjustment should not be required, variable resistors are provided to adjust the -5.2, -4,  $\pm 12$ , -5 Vdc output voltages within the tolerance specified, if necessary.

### 3.2 INTERFACE PCBs

#### (1) INTERFACE PCB - DQEMU (B16B-8140-0010A#U)

Drive logical address 0 to 7 can be set with three positions of the switch in binary code as shown in Table 3.2-1.

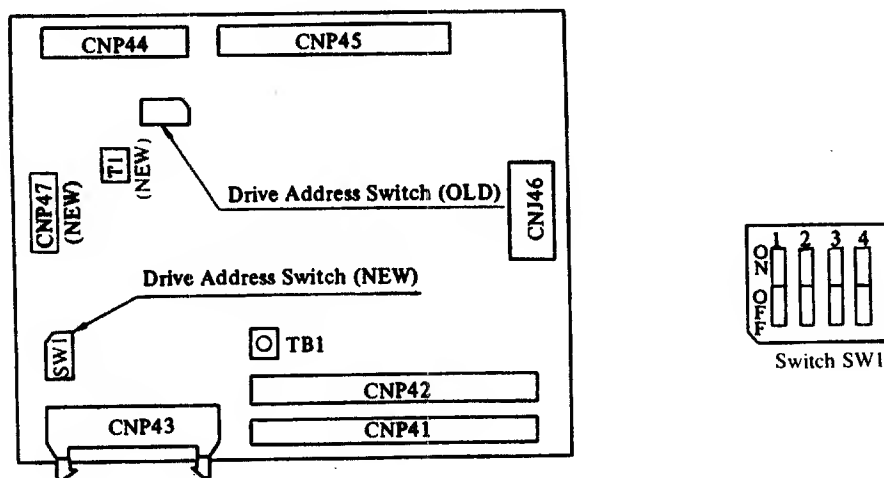


Figure 3.2-1 Drive Address Switch

Table 3.2-1 Drive Addressing

| Drive Address | Switch Position |     |     |             |
|---------------|-----------------|-----|-----|-------------|
|               | 1               | 2   | 3   | 4           |
| 0             | OFF             | OFF | OFF | Not<br>Used |
| 1             | ON              | OFF | OFF |             |
| 2             | OFF             | ON  | OFF |             |
| 3             | ON              | ON  | OFF |             |
| 4             | OFF             | OFF | ON  |             |
| 5             | ON              | OFF | ON  |             |
| 6             | OFF             | ON  | ON  |             |
| 7             | ON              | ON  | ON  |             |

# Interface Configuration Jumper (T1)

In normal dual port operation, a Priority Select on one port will cause the B Cable Interface on the alternate port to be disabled. Also, a Seek-End response is given for Reserve (Select) and Reserve (Select) Release commands.

Jumper T1 provides the means to inhibit the disabling of the alternate port's B Cable Interface in response to a Priority Select. (See also - Table 3.2-3 for DQFMU, Jumpers T1, T2 & T3)

Table 3.2-2 DQEMU Interface Configuration

| Jumper # | Pin Numbers | Option                                         |
|----------|-------------|------------------------------------------------|
| T1       | 01-02*      | Disable B cable with Priority Select           |
| (Port A) | 02-03       | Inhibit disabling B cable with Priority Select |

\* Jumper position for normal dual port operation

## (2) DUAL CHANNEL INTERFACE PCB ----- DQFMU (B16B-8150-0010A#U)

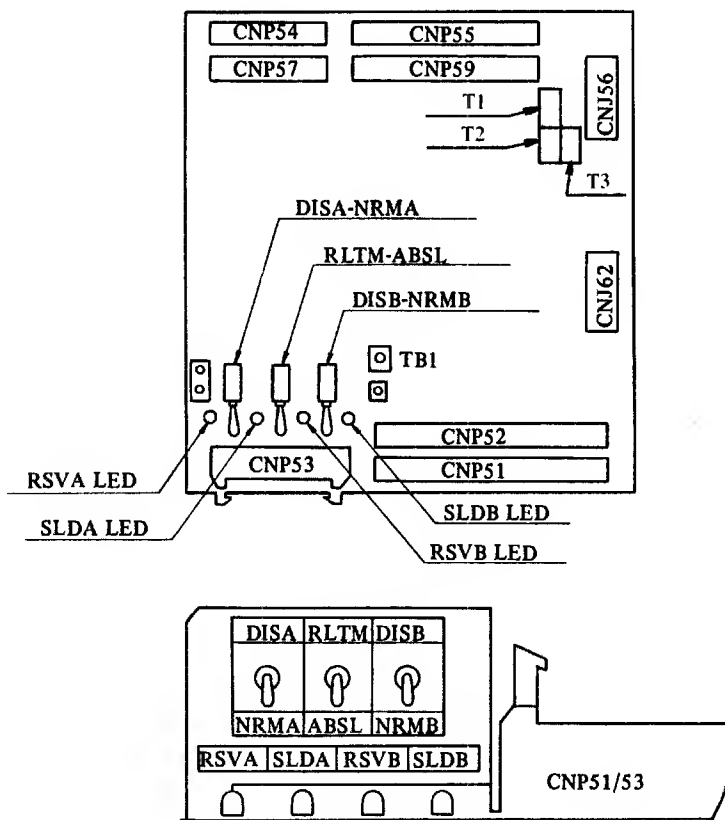


Figure 3.2-2 Switches and Indicators

## LEDs

(1) RSVA (Channel A Reserved) – Orange  
Indicates that the drive is reserved by A-channel.

(2) SLDA (Channel A Selected) – Green  
Indicates that the drive is selected by A-channel.

(3) RSVB (Channel B Reserved) – Orange  
Indicates that the drive is reserved by B-channel.

(4) SLDB (Channel B Selected) – Green  
Indicates that the drive is selected by B-channel.

## Switches

(1) DISA – NRMA (Disable A – Normal A)  
Disconnects or connects the interface signals of A-channel.

(2) RLTM – ABSL (Release Timer – Absolute)  
When the switch is at RLTM side, reserved status will be released 500 ms after Unit Select Command if the Release Command has not already been issued. When the switch is at ABSL side, reserved status can be released only by the Release Command.

(3) DISB – NRMB (Disable B – Normal B)  
Disconnects or connects the interface signals of B-channel.

## Interface Configuration Jumpers (T1, T2, T3)

In normal dual port operation, a Priority Select on one port will cause the B Cable Interface on the alternate port to be disabled. Also, a Seek-end response is given for Reserve (Select) and Reserve (Select) Release commands.

Jumpers T1 and T2 provide a means to inhibit the Seek-end response to Reserve (Select) and Reserve (Select) Release commands.

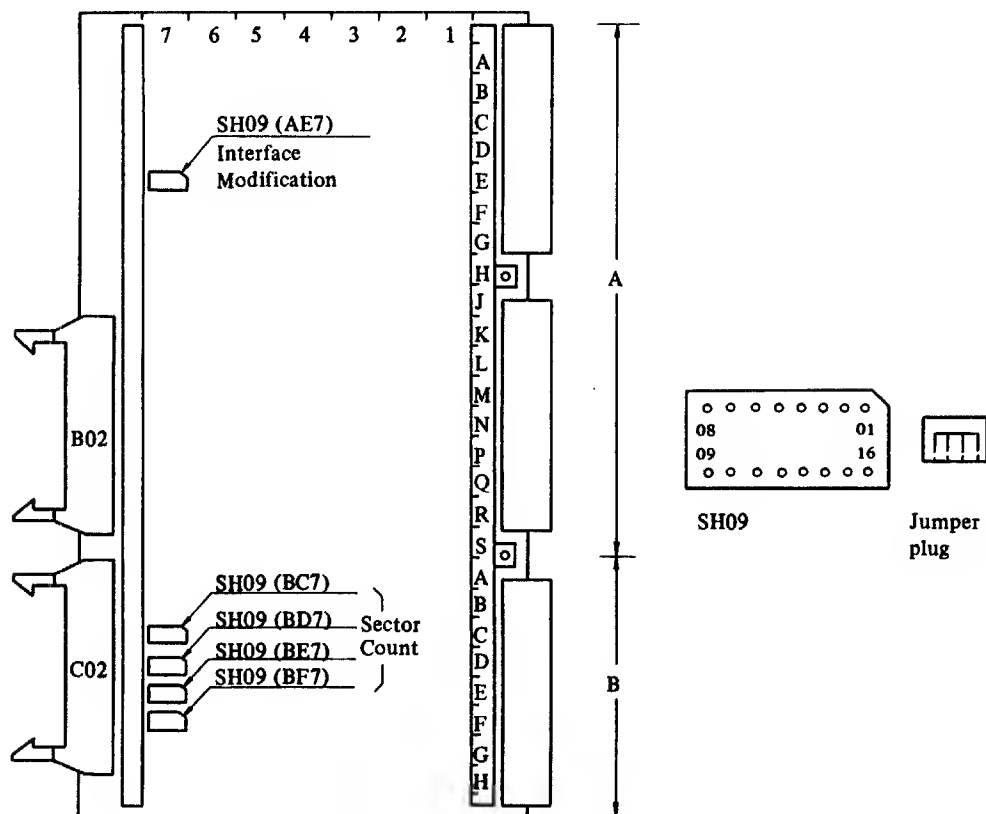
Jumper T3 provides the means to inhibit the disabling of the alternate port's B Cable Interface in response to a Priority Select.

Table 3.2-3 DQFMU Interface Configuration

| Jumper #       | Pin Numbers | Option                                                 |
|----------------|-------------|--------------------------------------------------------|
| T1<br>(Port A) | 01-02*      | Seek-End response for Reserve/Release command.         |
|                | 02-03       | Inhibit Seek-End response for Reserve/Release command. |
| T2<br>(Port B) | 01-02*      | Seek-End response for reserve/release command.         |
|                | 02-03       | Inhibit Seek-End response for reserve/release command. |
| T3<br>(Port B) | 01-02*      | Disable B cable with Priority Select                   |
|                | 02-03       | Inhibit disabling B cable with Priority Select         |

\* Jumper position for normal dual-port operation.

Jumper pins (SH09) and jumper plugs for setting sector count and changing interface requirements are provided.



**Figure 3.3-1 Sector Count and Interface Selection**

Removal of the Logic PCB is required to set the sector count or change the interface options. This is accomplished with the extractor tools provided with the drive (refer to Table 1.9-1, item 4) as shown below.

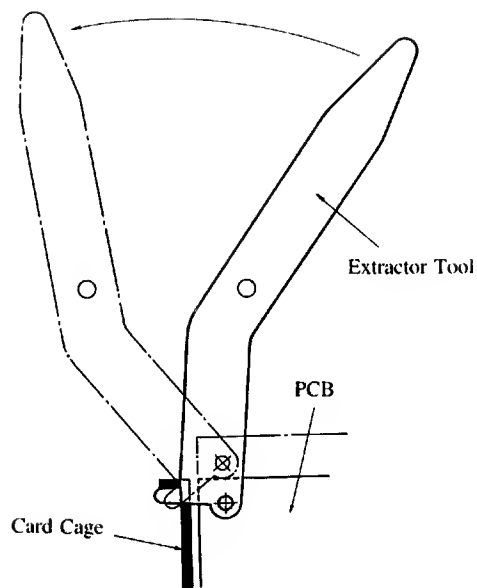


Figure 3.3-2 PCB Removal

#### (1) Interface Configuration

The interface can be reconfigured by shorting the appropriate pins (Logic PCB, Location AE 7) with jumper plugs, as shown below.

Table 3.3-1 Interface Selection

| Item                                    | Pin number to be shortened | Default mode | Function                                                         |
|-----------------------------------------|----------------------------|--------------|------------------------------------------------------------------|
| Incorporate * TAG4, 5 Status Capability | 03 - 02                    | x            | Enable                                                           |
|                                         | 03 - 04                    |              | Disable                                                          |
| Operation of Seek End status            | 06 - 05                    |              | Seek End is not issued after Offset Command is reset.            |
|                                         | 06 - 07                    | x            | Seek End is issued after Offset Command is reset.                |
| Response of Unit Ready                  | 10 - 09                    | x            | Unit Ready is issued even if the drive is in a fault condition.  |
|                                         | 10 - 11                    |              | Unit Ready is not issued when the drive is in a fault condition. |

\* (Note) It is recommended that tag 4 & 5 be disabled if the disk controller does not use the option.

### 3.4 SECTOR COUNT

The number of bytes per sector in Fixed Sector Format is determined by the location of jumper plugs according to the following table and example.

Example; 9 Sectors/Track

$$\text{Bytes/Sector} = \frac{\text{Bytes/Track}}{\text{Sectors/Track}} = \frac{28,160}{9} = 3,128.89$$

If the above calculation results in a remainder, round it up to the next integer, i.e.,

$$\text{Bytes/Sector} = 3,129$$

Set this figure minus one with jumper plugs to allow the Byte Counter to start counting from zero.

$$3,129-1 = 3,128 = \underbrace{2,048}_{\text{BE7}} + \underbrace{1,024}_{\text{BD7}} + \underbrace{32}_{\text{BC7}} + \underbrace{16}_{\text{BC7}} + \underbrace{8}_{\text{BC7}}$$

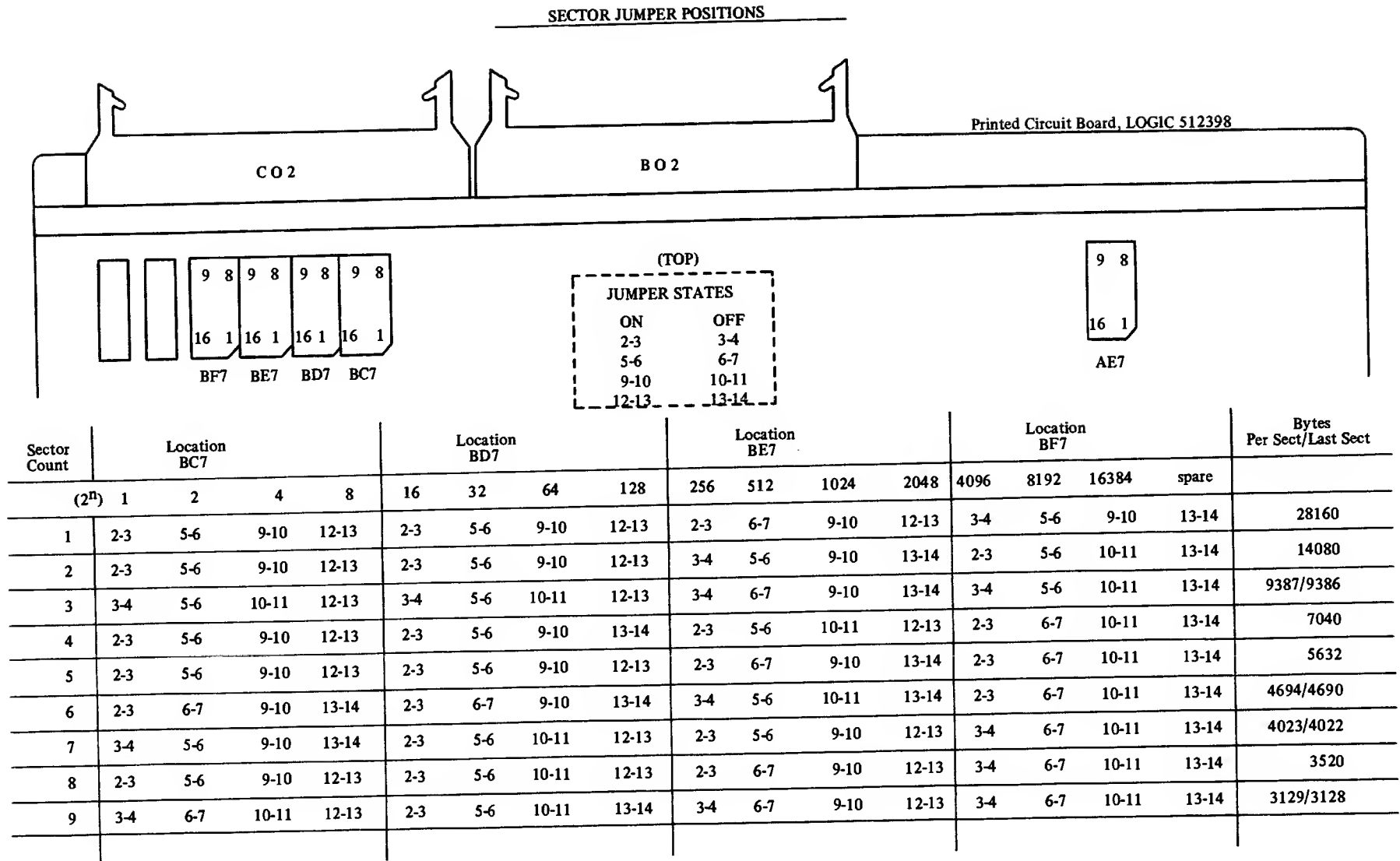
Therefore, jumper plugs should be placed on pins 13 - 12 and 10 - 9 of BE7, pins 06 - 05 and 03 - 02 of BD7, and pins 13 - 12 of BC7. However, those pins representing byte-count value not appearing in the calculation must also be jumpered (the complementary position).

In this case, the number of bytes in the last sector is calculated as follows.

$$28,160 - (8 \times 3,129) = 3,128$$

Namely, the last sector is one byte shorter than the others.

Table 3.4-1 Setting of Sector Count



B03P-4655-0001A...E1



[illegible]

| Sector<br>Count   | Location<br>BC7 |     |       |       | Location<br>BD7 |     |       |       | Location<br>BE7 |     |       |       | Location<br>BF7 |      |       |       | Bytes<br>Per Sect/Last Sect |
|-------------------|-----------------|-----|-------|-------|-----------------|-----|-------|-------|-----------------|-----|-------|-------|-----------------|------|-------|-------|-----------------------------|
| (2 <sup>n</sup> ) | 1               | 2   | 4     | 8     | 16              | 32  | 64    | 128   | 256             | 512 | 1024  | 2048  | 4096            | 8192 | 16384 | spare |                             |
| 33                | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 854/832                     |
| 34                | 3-4             | 6-7 | 9-10  | 12-13 | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 829/803                     |
| 35                | 3-4             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 805/790                     |
| 36                | 3-4             | 5-6 | 9-10  | 12-13 | 3-4             | 6-7 | 10-11 | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 783/755                     |
| 37                | 2-3             | 6-7 | 10-11 | 12-13 | 2-3             | 5-6 | 9-10  | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 762/728                     |
| 38                | 2-3             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 9-10  | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 742/706                     |
| 39                | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 9-10  | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 723/686                     |
| 40                | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 5-6 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 704                         |
| 41                | 3-4             | 5-6 | 9-10  | 12-13 | 3-4             | 5-6 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 687/680                     |
| 42                | 3-4             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 671/649                     |
| 43                | 3-4             | 5-6 | 9-10  | 12-13 | 3-4             | 6-7 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 655/650                     |
| 44                | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 5-6 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 640                         |
| 45                | 2-3             | 6-7 | 10-11 | 13-14 | 2-3             | 5-6 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 626/616                     |
| 46                | 3-4             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 613/575                     |
| 47                | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 600/560                     |
| 48                | 3-4             | 5-6 | 10-11 | 12-13 | 3-4             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 587/571                     |
| 49                | 3-4             | 5-6 | 9-10  | 12-13 | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 575/560                     |
| 50                | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 564/524                     |
| 51                | 3-4             | 6-7 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 553/510                     |
| 52                | 2-3             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 542/518                     |
| 53                | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 532/496                     |
| 54                | 2-3             | 6-7 | 10-11 | 12-13 | 3-4             | 6-7 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 522/494                     |
| 55                | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 512                         |
|                   |                 |     |       |       |                 |     |       |       |                 |     |       |       |                 |      |       |       |                             |

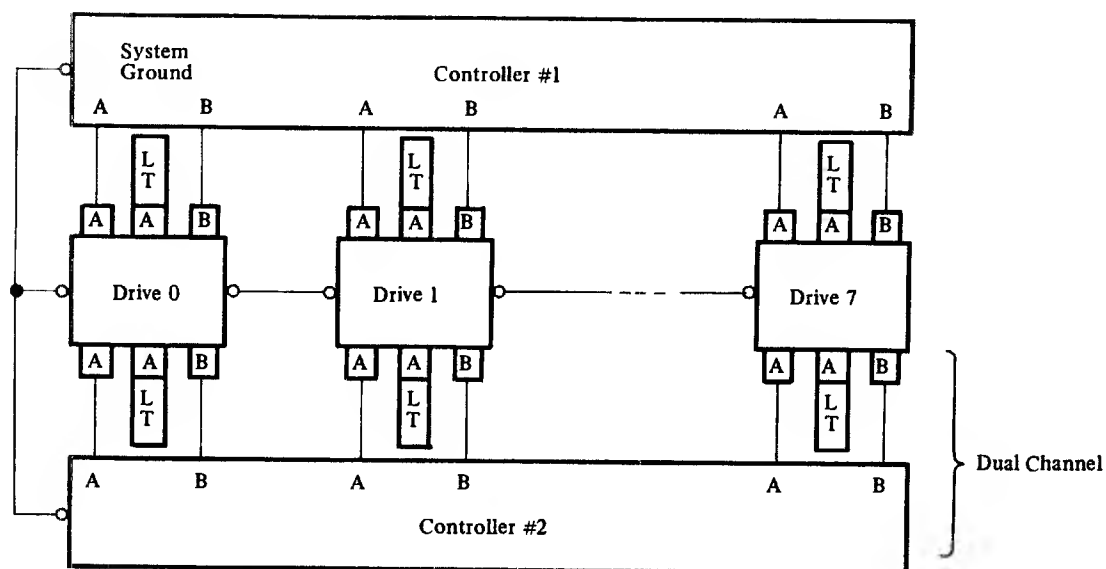
| Sector<br>Count   | Location<br>BC7 |     |       |       | Location<br>BD7 |     |       |       | Location<br>BE7 |     |       |       | Location<br>BF7 |      |       |       | Bytes<br>Per Sect/Last Sect |
|-------------------|-----------------|-----|-------|-------|-----------------|-----|-------|-------|-----------------|-----|-------|-------|-----------------|------|-------|-------|-----------------------------|
| (2 <sup>B</sup> ) | 1               | 2   | 4     | 8     | 16              | 32  | 64    | 128   | 256             | 512 | 1024  | 2048  | 4096            | 8192 | 16384 | spare |                             |
| 56                | 3-4             | 5-6 | 9-10  | 13-14 | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 503/495                     |
| 57                | 3-4             | 5-6 | 9-10  | 12-13 | 3-4             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 495/440                     |
| 58                | 2-3             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 486/458                     |
| 59                | 2-3             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 478/436                     |
| 60                | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 470/430                     |
| 61                | 2-3             | 6-7 | 9-10  | 12-13 | 3-4             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 462/440                     |
| 62                | 3-4             | 5-6 | 9-10  | 13-14 | 3-4             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 455/405                     |
| 63                | 3-4             | 5-6 | 9-10  | 12-13 | 2-3             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 447/446                     |
| 64                | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 440                         |
| 65                | 2-3             | 6-7 | 10-11 | 13-14 | 2-3             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 434/384                     |
| 66                | 3-4             | 5-6 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 427/405                     |
| 67                | 3-4             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 421/374                     |
| 68                | 3-4             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 415/355                     |
| 69                | 3-4             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 409/348                     |
| 70                | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 403/353                     |
| 71                | 3-4             | 6-7 | 9-10  | 12-13 | 3-4             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 397/370                     |
| 72                | 2-3             | 5-6 | 9-10  | 13-14 | 3-4             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 392/328                     |
| 73                | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 386/368                     |
| 74                | 3-4             | 6-7 | 9-10  | 12-13 | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 381/347                     |
| 75                | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 376/336                     |
| 76                | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 371/335                     |
| 77                | 2-3             | 6-7 | 9-10  | 12-13 | 3-4             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 366/344                     |
| 78                | 2-3             | 6-7 | 10-11 | 12-13 | 3-4             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 362/286                     |

| Sector<br>Count   | Location<br>BC7 |     |       |       | Location<br>BD7 |     |       |       | Location<br>BE7 |     |       |       | Location<br>BF7 |      |       |       | Bytes<br>Per Sect/Last Sect |
|-------------------|-----------------|-----|-------|-------|-----------------|-----|-------|-------|-----------------|-----|-------|-------|-----------------|------|-------|-------|-----------------------------|
| (2 <sup>n</sup> ) | 1               | 2   | 4     | 8     | 16              | 32  | 64    | 128   | 256             | 512 | 1024  | 2048  | 4096            | 8192 | 16384 | spare |                             |
| 79                | 3-4             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 357/314                     |
| 80                | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 352                         |
| 81                | 2-3             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 348/320                     |
| 82                | 2-3             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 344/296                     |
| 83                | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 340/280                     |
| 84                | 2-3             | 5-6 | 9-10  | 12-13 | 3-4             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 336/272                     |
| 85                | 2-3             | 5-6 | 10-11 | 12-13 | 3-4             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 332/272                     |
| 86                | 2-3             | 5-6 | 9-10  | 13-14 | 3-4             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 328/280                     |
| 87                | 2-3             | 5-6 | 10-11 | 13-14 | 3-4             | 6-7 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 324/296                     |
| 88                | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 320                         |
| 89                | 3-4             | 6-7 | 9-10  | 12-13 | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 317/264                     |
| 90                | 3-4             | 6-7 | 10-11 | 12-13 | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 313/303                     |
| 91                | 2-3             | 6-7 | 9-10  | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 310/260                     |
| 92                | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 307/223                     |
| 93                | 3-4             | 5-6 | 9-10  | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 303/284                     |
| 94                | 2-3             | 5-6 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 300/260                     |
| 95                | 3-4             | 6-7 | 10-11 | 12-13 | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 297/242                     |
| 96                | 2-3             | 6-7 | 9-10  | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 294/230                     |
| 97                | 3-4             | 5-6 | 10-11 | 13-14 | 3-4             | 5-6 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 291/224                     |
| 98                | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 288/224                     |
| 99                | 3-4             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 285/230                     |
| 100               | 2-3             | 6-7 | 10-11 | 12-13 | 2-3             | 6-7 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 282/242                     |
| 101               | 3-4             | 5-6 | 9-10  | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 279/260                     |
|                   |                 |     |       |       |                 |     |       |       |                 |     |       |       |                 |      |       |       |                             |

| Sector Count      | Location BC7 |     |       |       | Location BD7 |     |       |       | Location BE7 |     |       |       | Location BF7 |      |       |       | Bytes Per Sect/Last Sect |
|-------------------|--------------|-----|-------|-------|--------------|-----|-------|-------|--------------|-----|-------|-------|--------------|------|-------|-------|--------------------------|
| (2 <sup>n</sup> ) | 1            | 2   | 4     | 8     | 16           | 32  | 64    | 128   | 256          | 512 | 1024  | 2048  | 4096         | 8192 | 16384 | spare |                          |
| 102               | 3-4          | 6-7 | 9-10  | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 277/183                  |
| 103               | 2-3          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 274/212                  |
| 104               | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 271/247                  |
| 105               | 3-4          | 6-7 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 269/184                  |
| 106               | 2-3          | 6-7 | 10-11 | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 266/230                  |
| 107               | 2-3          | 5-6 | 9-10  | 13-14 | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 264/176                  |
| 108               | 3-4          | 6-7 | 9-10  | 13-14 | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 261/233                  |
| 109               | 3-4          | 5-6 | 10-11 | 13-14 | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 259/188                  |
| 110               | 2-3          | 5-6 | 9-10  | 12-13 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 256                      |
| 111               | 2-3          | 6-7 | 9-10  | 12-13 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 254/220                  |
| 112               | 2-3          | 5-6 | 10-11 | 12-13 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 252/188                  |
| 113               | 2-3          | 6-7 | 10-11 | 12-13 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 250/160                  |
| 114               | 2-3          | 5-6 | 9-10  | 13-14 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 248/136                  |
| 115               | 3-4          | 6-7 | 9-10  | 13-14 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 245/230                  |
| 116               | 3-4          | 5-6 | 10-11 | 13-14 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 243/215                  |
| 117               | 3-4          | 6-7 | 10-11 | 13-14 | 2-3          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 241/204                  |
| 118               | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 239/197                  |
| 119               | 3-4          | 6-7 | 9-10  | 12-13 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 237/194                  |
| 120               | 3-4          | 5-6 | 10-11 | 12-13 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 235/195                  |
| 121               | 3-4          | 6-7 | 10-11 | 12-13 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 233/200                  |
| 122               | 3-4          | 5-6 | 9-10  | 13-14 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 231/209                  |
| 123               | 3-4          | 6-7 | 9-10  | 13-14 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 229/222                  |
| 124               | 2-3          | 5-6 | 10-11 | 13-14 | 3-4          | 5-6 | 9-10  | 12-13 | 3-4          | 6-7 | 10-11 | 13-14 | 3-4          | 6-7  | 10-11 | 13-14 | 228/116                  |
|                   |              |     |       |       |              |     |       |       |              |     |       |       |              |      |       |       |                          |

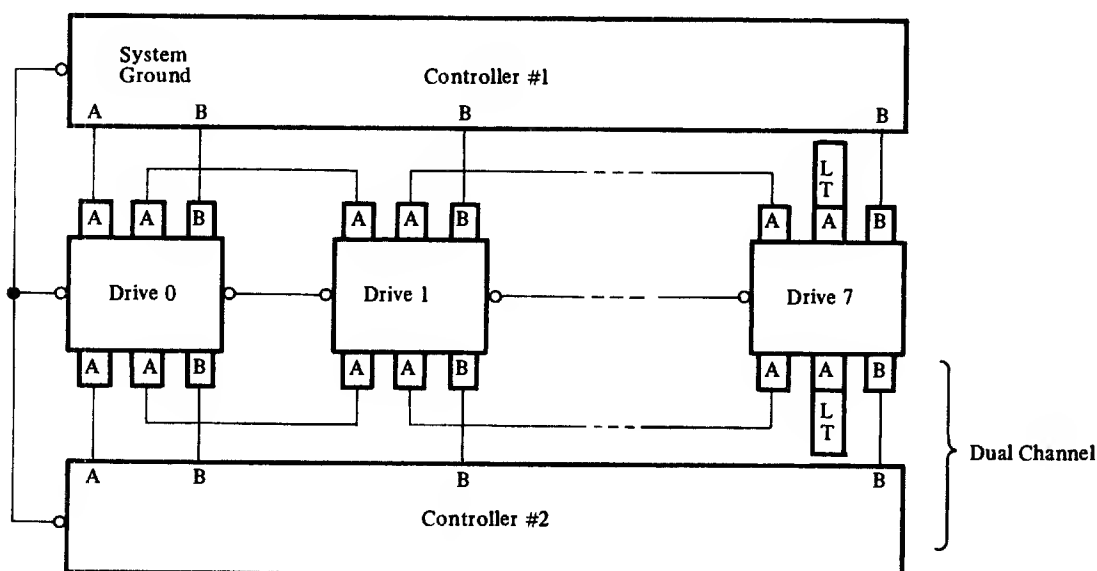
| Sector<br>Count   | Location<br>BC7 |     |       |       | Location<br>BD7 |     |      |       | Location<br>BE7 |     |       |       | Location<br>BF7 |      |       |       | Bytes<br>Per Sect/Last Sect |
|-------------------|-----------------|-----|-------|-------|-----------------|-----|------|-------|-----------------|-----|-------|-------|-----------------|------|-------|-------|-----------------------------|
| (2 <sup>n</sup> ) | 1               | 2   | 4     | 8     | 16              | 32  | 64   | 128   | 256             | 512 | 1024  | 2048  | 4096            | 8192 | 16384 | spare |                             |
| 125               | 2-3             | 6-7 | 10-11 | 13-14 | 3-4             | 5-6 | 9-10 | 12-13 | 3-4             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 226/136                     |
| 126               | 2-3             | 5-6 | 9-10  | 12-13 | 2-3             | 6-7 | 9-10 | 12-13 | 3-4             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 224/160                     |
| 127               | 2-3             | 6-7 | 9-10  | 12-13 | 2-3             | 6-7 | 9-10 | 12-13 | 3-4             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 222/188                     |
| 128               | 2-3             | 5-6 | 10-11 | 12-13 | 2-3             | 6-7 | 9-10 | 12-13 | 3-4             | 6-7 | 10-11 | 13-14 | 3-4             | 6-7  | 10-11 | 13-14 | 220                         |
|                   |                 |     |       |       |                 |     |      |       |                 |     |       |       |                 |      |       |       |                             |

One of the following interface cable configurations must be chosen depending on the feature of the controller. (Note; Dual Channel Feature is optional.)



Note that Line Terminators (LT) are required in each drive in a radial cable configuration.

Figure 3.5-1 Radial Cable Configuration



Note that a Line Terminator (LT) is required in the last drive in a daisy-chain cable configuration.

Figure 3.5-2 Daisy-Chain Cable Configuration

### 3.5 OPERATOR PANEL

Switches and indicators on the operator panel are shown in Figure 3.5-1.

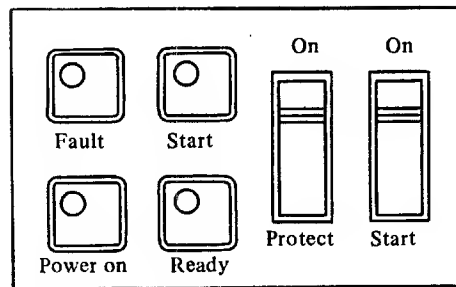


Figure 3.5-1 Operator Panel

#### (1) Start-On (Switch)

When the Remote/Local switch on the control panel of DC power supply unit is set to Local, this switch enables rotation of the spindle motor. The heads start Initial Seek operation and stop on the cylinder zero, approximately 40 seconds later, lighting the Ready lamp. The spindle motor stops rotating approximately 15 seconds after the switch is set to off position.

When the Remote/Local switch is set to Remote, the spindle motor starts and stops rotating in accordance with the Power Sequence Pick/Hold commands issued from the controller if the Start switch is On.

#### (2) Protect-On (Switch)

Inhibits Write operation. If a write command is issued from the controller while the switch is On, the Fault and Control Check conditions will be returned to the controller. Note: The function of the Protect Switch can only occur with the selection of the drive. If the drive is selected prior to the switch being turned on, it must be deselected, then reselected to enable File Protect.

#### (3) Start (LED)

Indicates that the spindle is rotating.

#### (4) Ready (LED)

Indicates that the spindle has reached the rated speed and no fault condition exists in the drive. It goes off when the heads are seeking to the desired cylinder.



(5) Fault (LED and Switch)

Indicates a Fault condition (i.e., R/W check status) or a Seek Error.  
Depressing the indicator switch clears this condition.

(6) Power On

Indicates that the DC power supply unit is on.

### 3.6 INDICATOR UNIT ----- HGAMU (B16B-7830-0010A/U)

These switches and indicators are provided for aiding maintenance, and are shown in Figure 3.6-1.

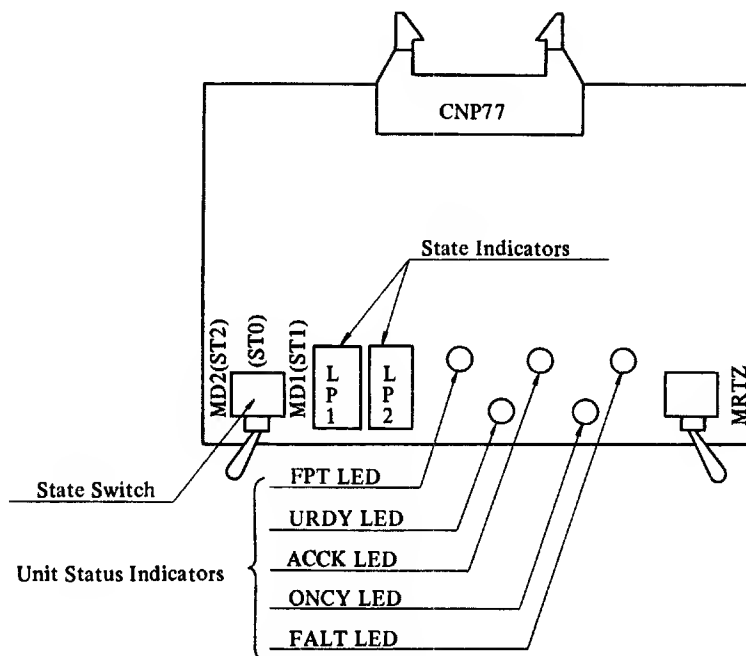


Figure 3.6-1 Switches and Indicators

#### (1) Unit Status Indicators (LEDs)

Indicate Unit Status as shown in Table 3.6-1. These statuses are also issued to the controller as States 0 to 4 when both Tag 4 and 5 are false if this feature is utilized.

Refer to item (2-1) ~ (2-5) in Section 7.4 for detailed descriptions of each state.

Table 3.6-1 Unit Status Indicators

| Name of LED | Color of LED | Content                        |
|-------------|--------------|--------------------------------|
| URDY        | Green        | Unit Ready                     |
| ONCY        | Green        | On Cylinder                    |
| ACCK        | Red          | Seek Error (Access Check)      |
| FALT        | Red          | Fault                          |
| FPT         | Yellow       | Write Protected (File Protect) |

(2) State Switch and State Indicators (Toggle Switch and 7-Segment LEDs)

Two 7-segment LEDs indicate detailed drive states as shown in Table 3.6-2 in accordance with the position of the State Switch.

Table 3.6-2 Status and State

| State Switch Position |       | Left (MD 2)             | Center (MD 0)               | Right (MD1)          |
|-----------------------|-------|-------------------------|-----------------------------|----------------------|
| LED                   | STATE | DE Sequence State       | Write/Read Check State      | Access State         |
|                       | Bit   |                         |                             |                      |
| LP1                   | 1     | DE Sequence Latch 1     | Index Check                 | DE Sequence Check    |
|                       | 2     | DE Sequence Latch 2     | Control Check               | Access Timeout Check |
|                       | 4     | DE Sequence Latch 4     | Multi Head Check            | Over Shoot Check     |
|                       | 8     | Hall Alarm              | Head Short Check            | Rezero Mode Latch    |
| LP2                   | 1     | Motor At Speed          | Write Current on Read Check | Servo Latch          |
|                       | 2     | Inhibit DE Seq. Recycle | Write Transition Check      | Linear Mode Latch    |
|                       | 4     | Unit Ready              | Delta I Write Check         | Control Latch        |
|                       | 8     | Access Busy             | Servo Off-Track             | Wait Latch           |

DE Sequence Stage (MD 2)

DE Sequence 1, 2 and 4

Indicates Start/Stop status sequence of the DE. Details are described in item (5-1) of Section 7.4.

Hall Alarm

Indicates that all output signals from the hall-elements used to detect the pole position of the rotor in the spindle motor are high or low level simultaneously.

#### Motor At Speed

Indicates that the spindle motor is rotating at 3,961 RPM  $\pm 2\%$ .

#### Inhibit DE Sequence Recycle

Indicates that Run State Good goes false while the DE Sequence Latch is in State 7. Stop sequence of the DE may be inhibited hereafter. Switching off the drive power or pushing the Start switch to Off position clears this state.

#### Unit Ready

Indicates that the drive has reached the rated rotational speed and heads are positioned on track.

#### Access Busy

Indicates that the heads are in motion, i.e., heads are performing Seek, RTZ or Offset operation.

#### Write/Read Check State (MD 0)

Refer to item (4) in Section 7.4.

#### Access State (MD 1)

Refer to item (5) in Section 7.4.

#### (3) MRTZ (Manual RTZ) Switch

The head performs RTZ operation when this maintenance-aid switch is pressed.

### 3.7 STANDALONE CHECK

After the preceding Sections 3.1 through 3.6 have been applied as required (3.1, in particular), a basic standalone check of drive operation can be made. The rotary actuator must be unlocked (refer to Section 2.3). Proceed with the check as follows:

- (1) With the circuit breaker and Start switch OFF, plug in the AC line cord.
- (2) Turn the circuit breaker ON. The Power on LED on the operator panel should light. The blower motor starts.
- (3) Press the Start switch on the operator panel to ON. The Start LED on the operator panel should light. The DC motor will begin to rotate. Approximately 40 seconds later, the Ready LED on the operator panel should light, and the green On Cylinder and Unit Ready LEDs on the Indicator PCB should light.
- (4) Depress the MRTZ switch on the Indicator PCB and note that the drive executes a RTZ operation. The On Cylinder and Unit Ready LEDs should blink during the carriage motion and remain On when locked on Cylinder 0.

This basic check has significance for initial Power On, Heads Load, Lock-on and RTZ capabilities.

#### 4.1 CONTROL CABLE ("A" CABLE)

A description of the Control cable signals and Pin assignments will be found in Chapter 7.2.

"A" Cables may be installed radially or daisy-chained. Connect the "A" cable from the controller output port to the Interface PCB (DQEMU) or Dual channel PCB (DQFMU), (CNP 41 or 51), as shown in Figure 4.1-1. Note that Pin 1 is to the right when facing the rear of the drive.

In a daisy-chain configuration, the "A" cable will be continued by connecting another cable from the Terminator header, (CNP 42 or 52), to the next drives input (CNP 41 or 51).

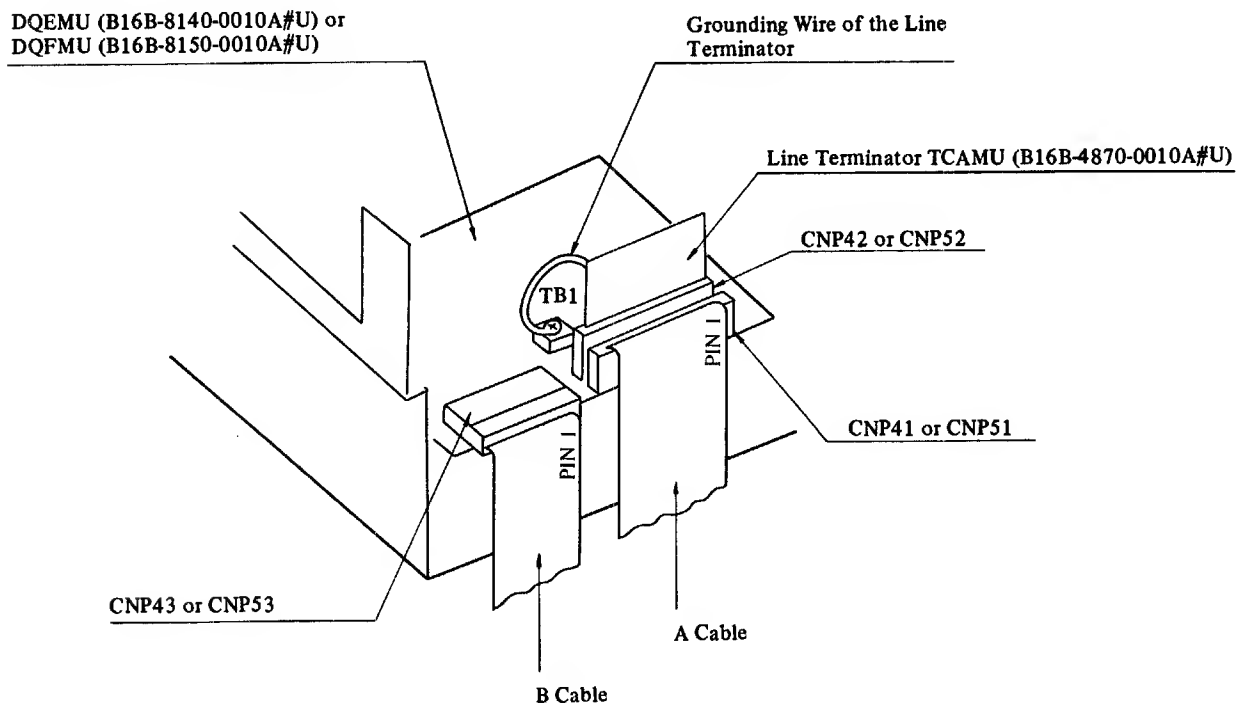


Fig. 4.1-1 Cable Connection

## 4.2 READ/WRITE CABLE ("B" CABLE)

A description of the Read/Write cable signals and Pin assignments will be found in Chapter 7.2.

"B" cables are always installed radially from the controller. Connect the "B" cable from the controller output port to the Interface PCB (DQEMU) or Dual Channel PCB (DQFMU), (CNP 43 or 53), as shown in Figure 4.1-1. Note that Pin 1 is to the right when facing the rear of the drive.

### 4.3 SYSTEM GROUNDING

#### (1) Definitions of SG, FG1 and FG2.

SG is Signal ground or DC ground and is isolated from AC ground within the drive.

FG1 is Frame ground or AC ground and is a direct short to chassis.

FG2 is a high impedance AC ground, connected to FG1 through a 510 Kohm resistor.

For shipment, SG is connected to FG2 with the shorting plate, as shown in Figure 4.3-1.

#### (2) Grounding Methods

It is always recommended that drives be grounded, and it is required if cable lengths longer than 10 ft. are used or if the drives are connected in the daisy-chain configuration. All grounding should be done with flat braided wire, preferably covered with a jacket or tubing. Note: Proper grounding is important for the operation of the drive.

Grounding methods vary with site and system integration design, and are commonly derived in a trial-and-error fashion. However, four approaches are offered in order of preference:

- (a) Connect SG to FG1 with the shorting plate. Connect a flat braid wire from SG to controller ground. If daisy-chained, daisy-chain the braid from SG to SG as shown in Figure 4.3-3.
- (b) Leave SG connected to FG2 (shipping configuration) and connect a flat braid wire to controller ground. If daisy-chained, daisy-chain the braid from SG to SG as shown in Figure 4.3-2.
- (c) Remove the shorting plate, isolating SG and FG grounds. Connect a flat braid wire from SG to controller ground (preferably DC ground). In this case, the braided wire must be covered to prevent accidental shorting to chassis (AC ground).
- (d) Leaving the same arrangement as in (c) above, connect another covered, braided wire from FG1 to controller chassis (AC ground).



### (3) AC Considerations

- (a) The controller should always be solidly connected to earth ground. The drives and the system are then grounded through the controller.  
(Controller AC-DC isolation is a function of design, and is assumed to be common in the four approaches described in (2) above.)
- (b) It is always recommended that the drive, controller and CPU share a common AC branch circuit.

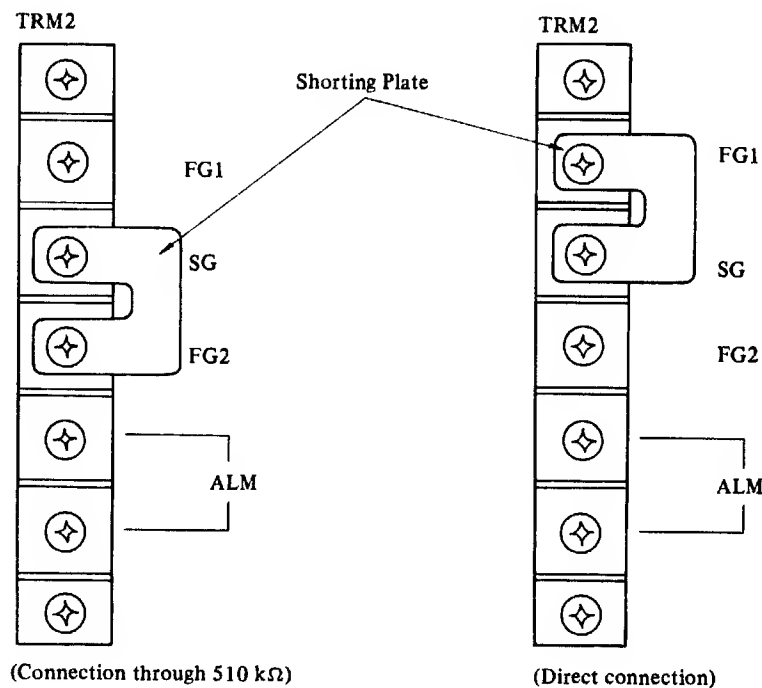


Fig. 4.3-1 Connection of FG and SG

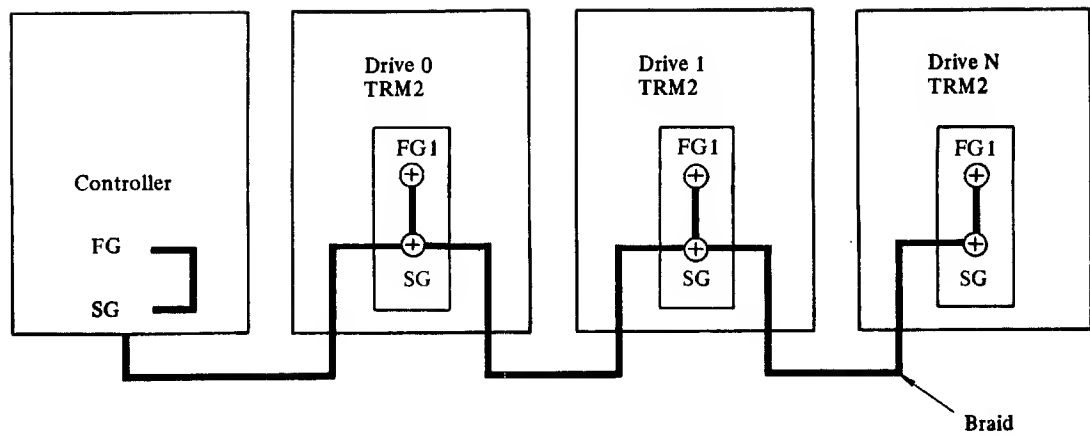


Fig. 4.3-2 SG/FG1 Common

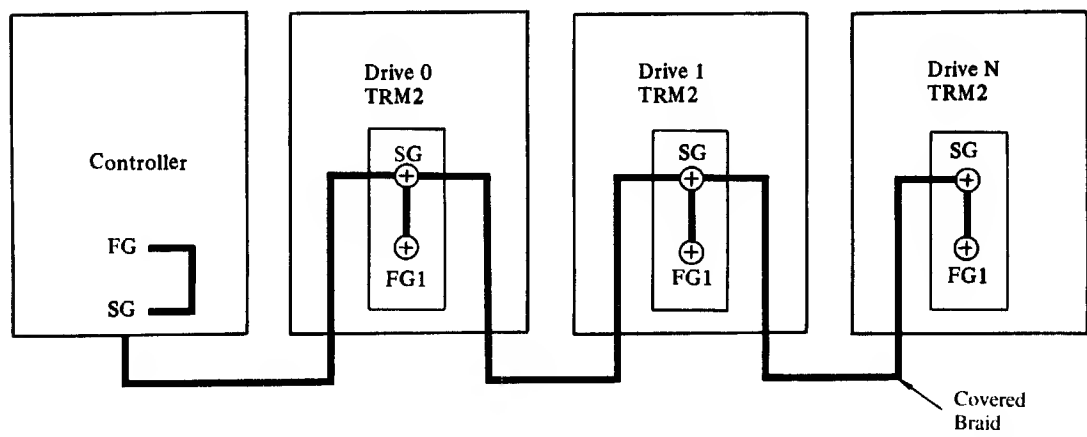


Fig. 4.3-3 SG/HI Z FG2 Common

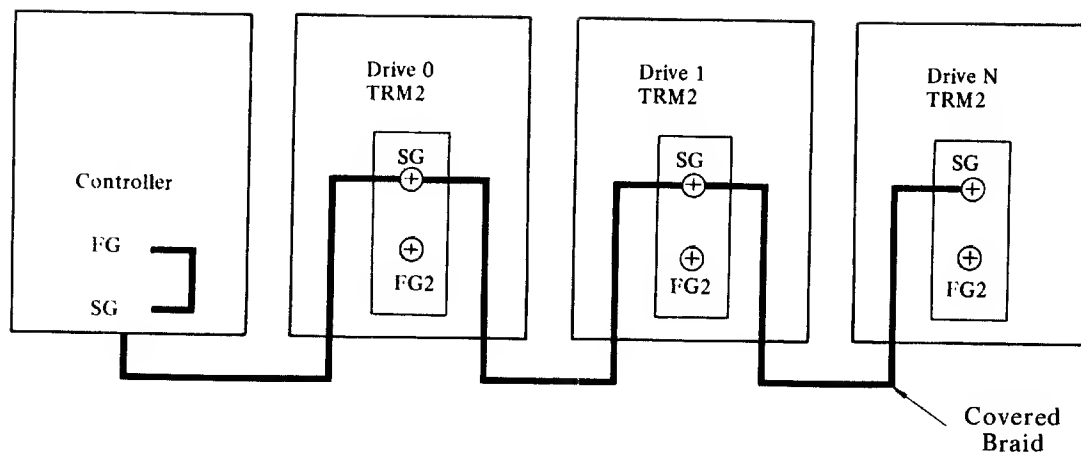


Fig. 4.3-4 SG/FG Isolated

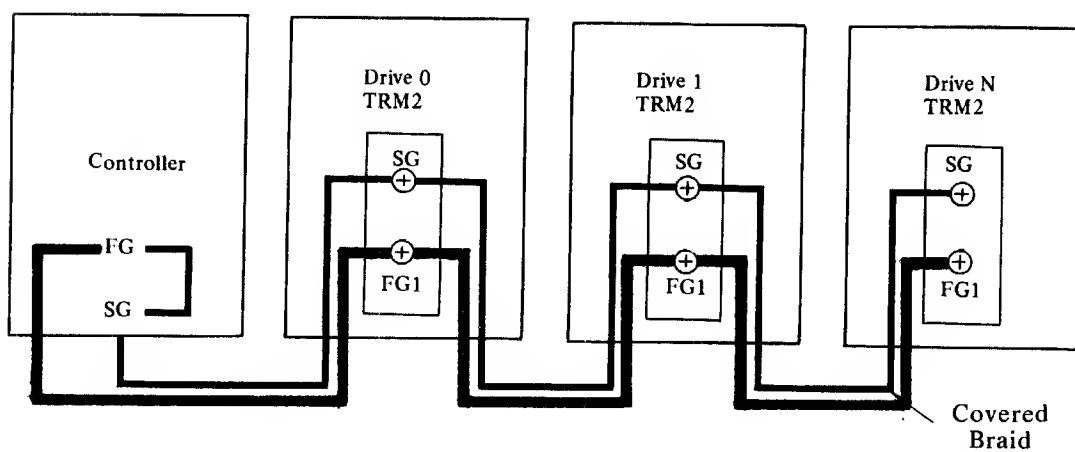


Fig. 4.3-5 SG/FG Isolated - Separate AC Ground

## CHAPTER 5 MECHANICAL ASSEMBLIES

### 5.1 CONSTRUCTION OF THE DRIVE

The overall construction is shown in Figure 5.1-1. The DE is supported horizontally at three points with rubber mounts for vibration and shock absorption. A shock sensor is provided on the DE to monitor for excess shock against the DE during shipping and handling. The rotary actuator is secured by a mechanical lock to prevent damage to the heads and disks during transportation. No mechanical lock is required for the spindle motor.

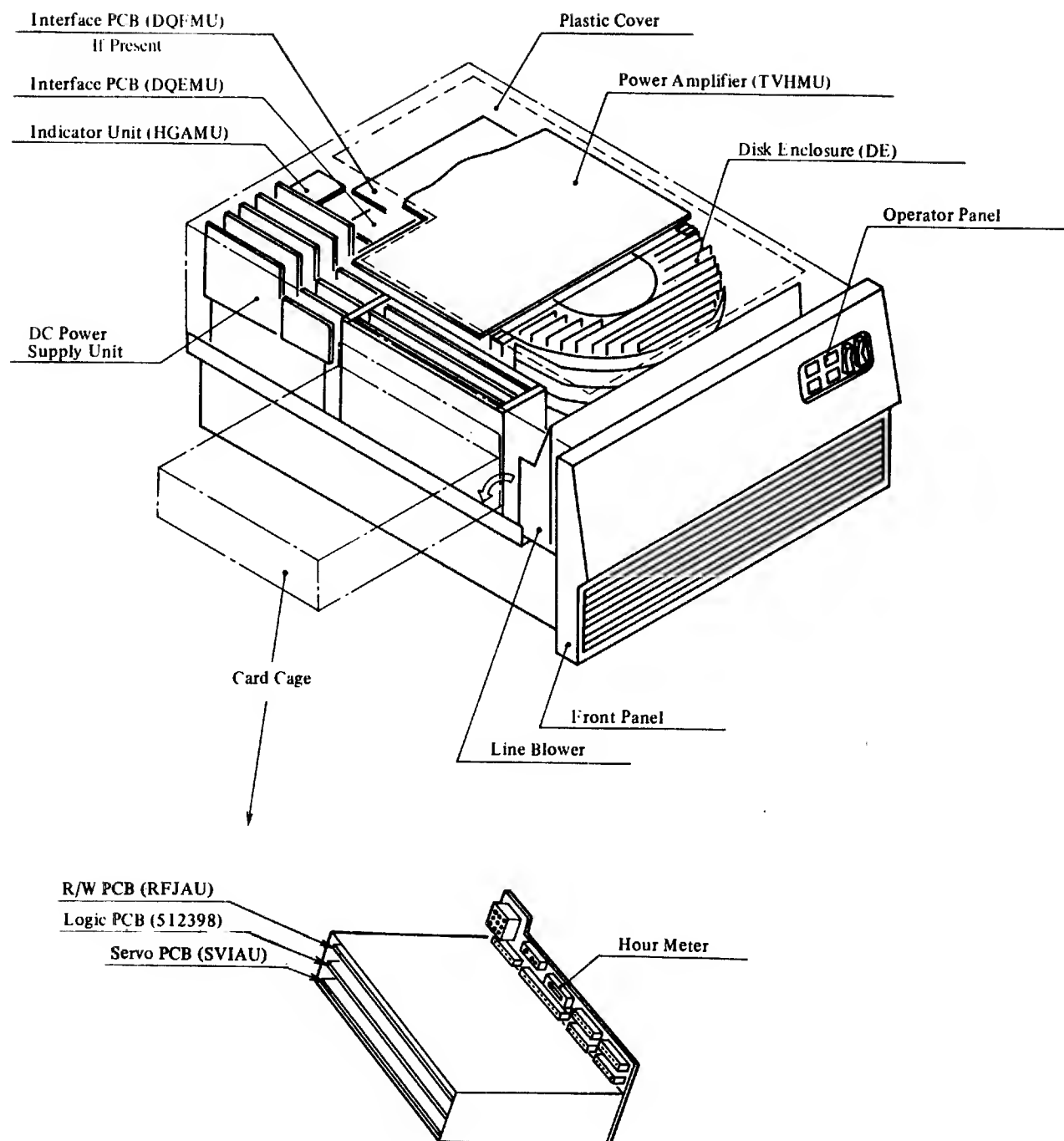
The Power Amplifier (TVHMU; B16B-8130-0010A#U or TVKMU; B16B-8800-0010A#U) which drives both spindle motor and rotary actuator is mounted horizontally above the DE (Old Version) or vertically behind the front panel (New Version).

Logic PCB (C16B-5123-0980#U), Servo Circuit (SVIAU; C16B-5501-0010#U) and Read/Write Circuit (RFJAU; C16B-5500-0990#U) are inserted in a card cage located at the side of the DE. This card cage can be pulled up and turned 90 degrees for access to the back panel (BQGMU; B16B-8160-0010A#U).

Indicator unit (HGAMU; B16B-7830-0010A#U) is attached on top of the DC Power Supply, located at the rear of the drive. Five LEDs and two 7-segment LED displays provide the status of the drive.

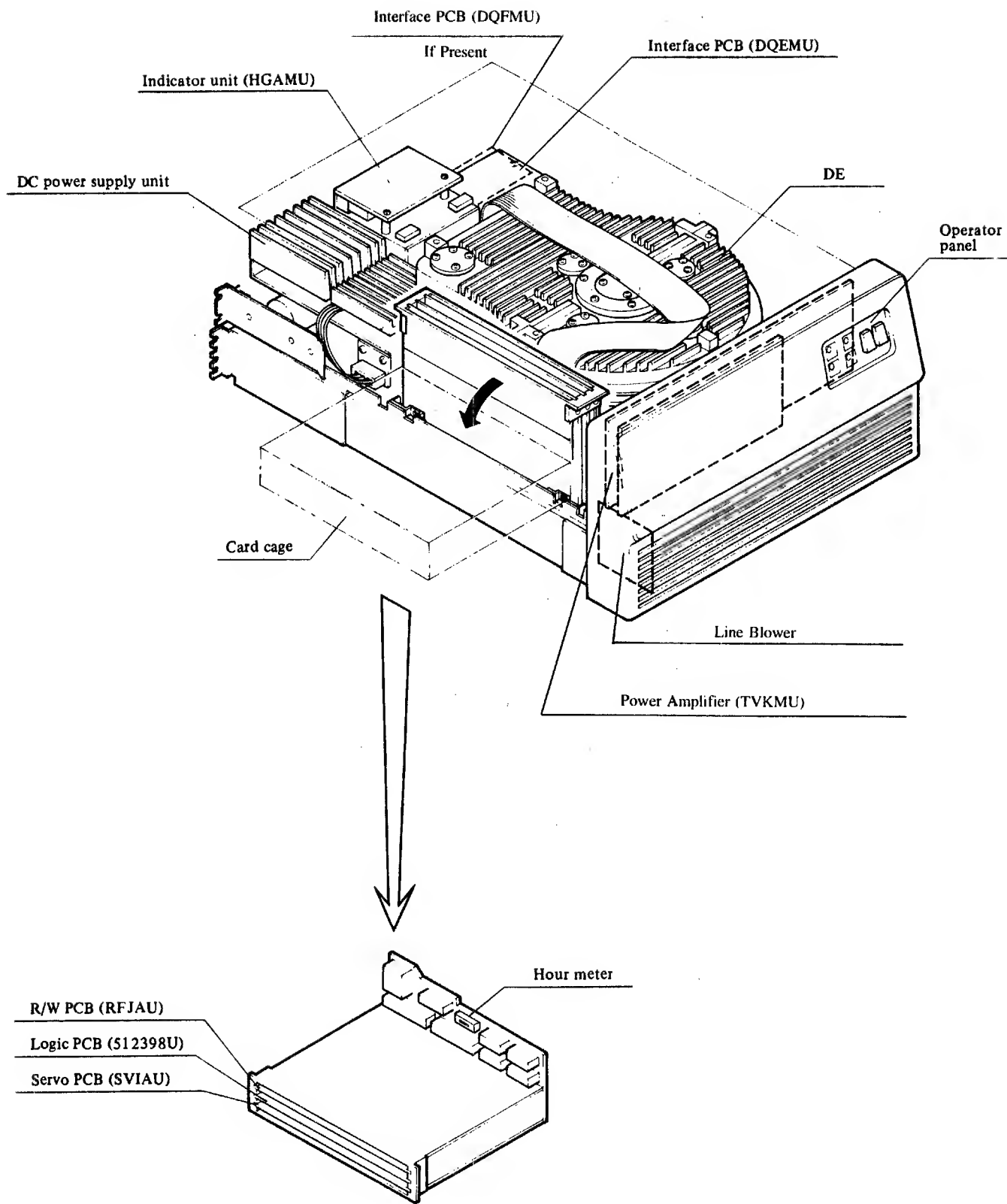
The interface PCBs are also located at the rear of the drive. When the sub-system is single channel, an interface PCB (DQEMU; B16B-8140-0010A#U) is placed in the lower position. When the sub-system is dual channel, an additional interface PCB (DQFMU; B16B-8150-0010A#U) must be placed in the upper position.

The entire drive is cooled by a line blower located at the front of the drive.



(a) Old version

Figure 5.1-1 Construction of the Drive



(b) New version

Figure 5.1-1 - Continued

## 5.2 DISK ENCLOSURE (DE)

### (1) Design Concept

The mechanical configuration of the DE shown in Figure 5.2-1 and 5.2-2 was designed to provide a compact, low power consumption, and maintenance-free file with enhanced performance. It features six 10.5 inch diameter disks and a rotary actuator with the fast average positioning time of 18 msec. The rotary actuator is completely balanced statically and dynamically by using a pair of moving coils, thereby avoiding undesired vibration that prolongs settling time.

### (2) Spindle and Base Casting

The primary function of the spindle is to maintain precise and constant rotation of the assembled disks. The accuracy of rotation involves concentricity, precision, thermal and dynamic stability; all of which become more stringent as the track spacing gets tighter.

The dual-supported spindle construction reduces this problem. In this design, the supporting casting is divided into two pieces in a plane parallel to the spindle axis, with one of the divided pieces substantially retaining the rotating bearings. Thus, precise concentricity can be maintained.

With regard to the base casting, it is important to keep the relative dimension between the spindle and rotary actuator very rigid, especially in a dynamic mode. This has been given critical attention as track spacing and access time become smaller and shorter.

In the present drive, the rotary actuator is designed so that the rotating axis is pivoted at both ends, similar to the spindle. A pair of arms are extended from the spindle bearing part to the pivoting element of the rotary actuator. This technique, combined with the high rigidity of the actuator, provides resonant-free seek operation.

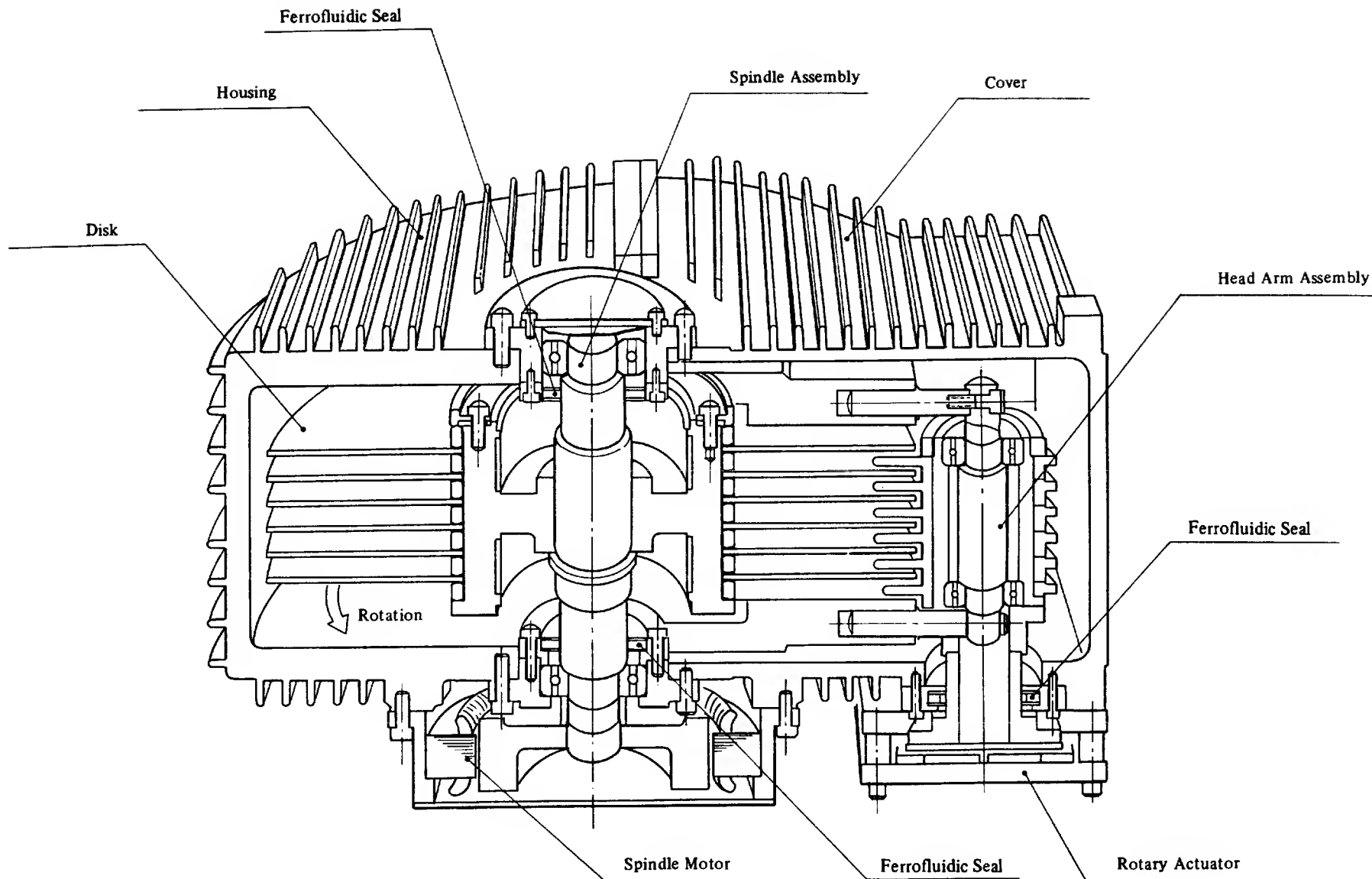


Figure 5.2-2 Cross Sectional View of the DE



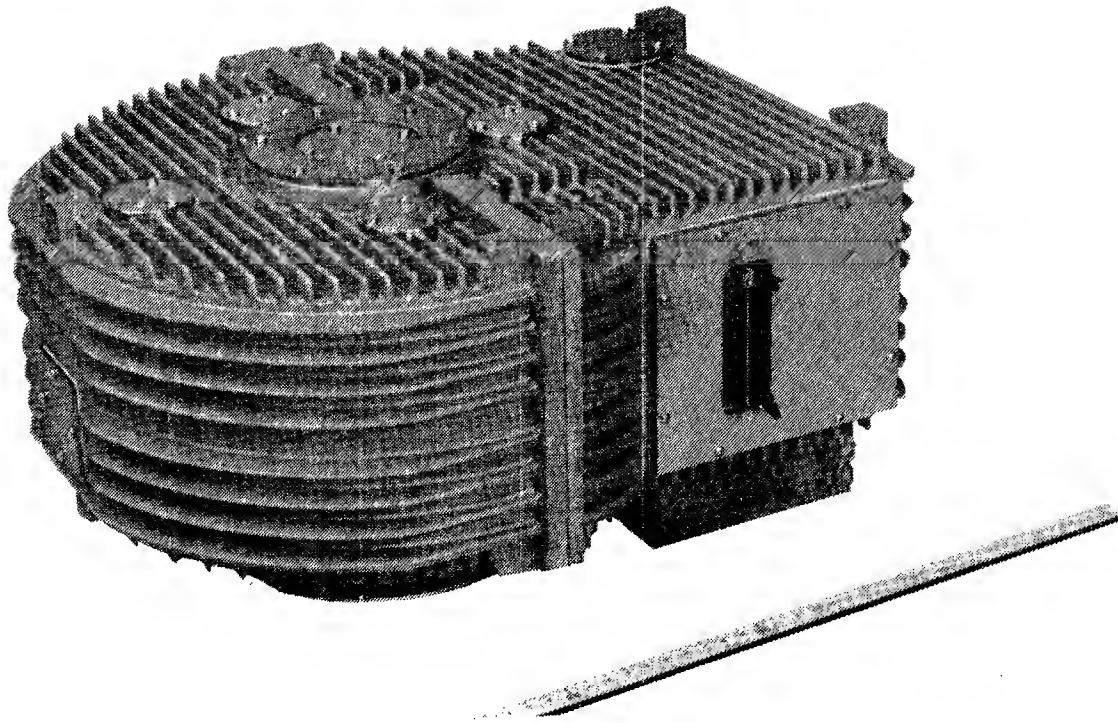


Figure 5.2-1 Outview of the DE

### (3) Air System

The fundamental and important function of the air system is to maintain an ultra-clean environment within the space of the DE to minimize the possibility of head-disk interference. In this DE, A new type of self circulating air system is provided. Features of the system are its simplicity and maintenance-free operation. Air flows through the disk spacings from the center to outside of the disks by the pressure difference between them, induced by the rotation of disks. An absolute filter, whose efficiency is 99.97 percent above  $0.3\ \mu\text{m}$  particle size dust, is attached within the spindle hub and is rotating with the disks. Particle count goes very nearly zero in a few minutes from the start of rotation. Ferrofluidic seals are adopted to complete the elimination of air contamination. To enhance the cooling efficiency, the housing is made entirely of aluminum casting with a high heat conductivity, and many fins formed around it. Air circulation is completely symmetrical in the disk stacking direction, and air flow

is well intermingled at the inside of disk hub for uniform and efficient cooling around the read/write heads along with the servo head.

### 5.3 ROTARY ACTUATOR

The drive shaft of the head-arm assembly in the DE is coupled directly to a bobbin supporting base to be driven by the rotary actuator outside the DE. Ferrofluidic seal is utilized to separate inside and outside the DE. Two coil-bobbins are attached to the bobbin supporting base, and two magnetic circuits are provided to supply torque to the coil bobbins, moving the head-arm assembly to the desired cylinder within a short access time.

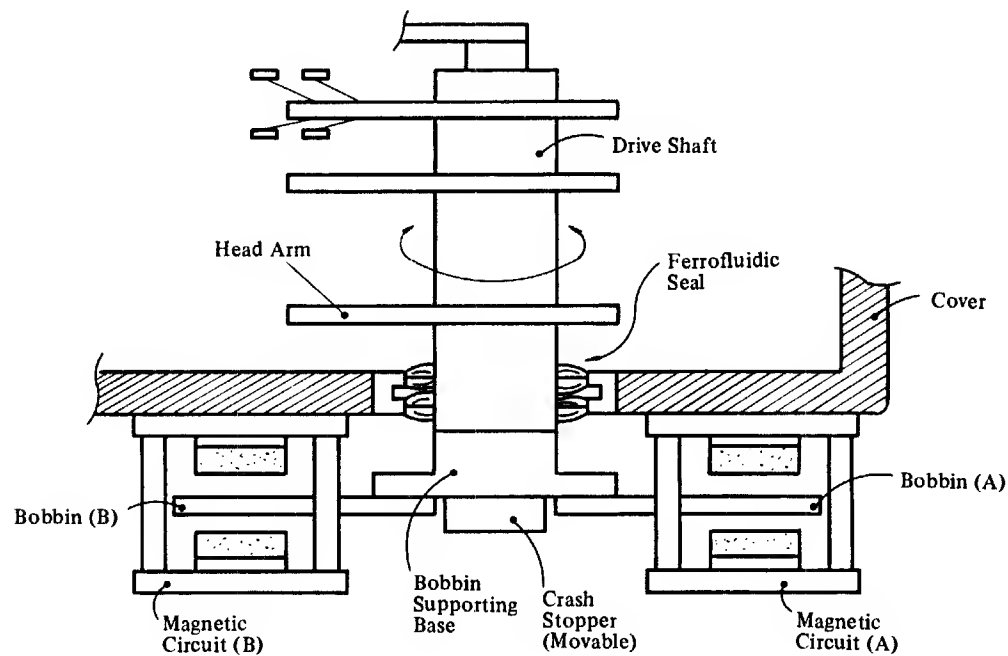


Figure 5.3-1 Construction of the Actuator

### (1) Magnetic Circuit

The pair of magnetic circuits are constructed symmetrically as shown in Figure 5.3-2. Each circuit incorporates four permanent magnets (rare earth magnets) with two magnetic gaps in between. Each magnetic gap contains a uniformly spread magnetic field. The coil bobbin is inserted in it and generates torque proportional to the current in the coil and the intensity of the magnetic field. This torque is sufficient to move the head-arm assembly at the specified speed.

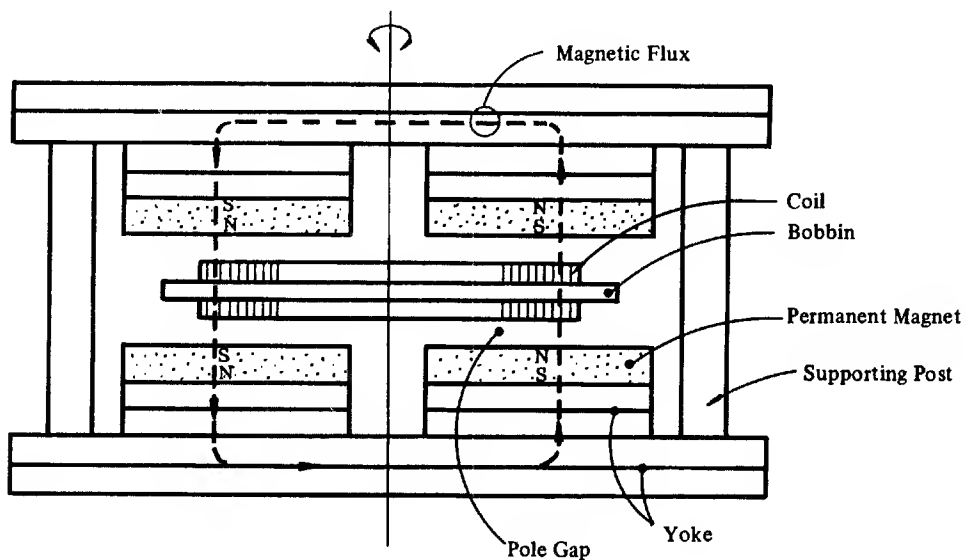


Figure 5.3-2 Magnetic Circuit

## (2) Drive Coil

The two coil bobbins are identical. A pair of flat copper wire coils are attached on the front and rear side of each coil bobbin. The four coils are then connected in series to generate torque in the same direction due to the current flowing in each coil.

## (3) Crash Stopper

The crash stopper consists of a moving part attached to the bobbin supporting base and fixed parts on the DE. It determines the movable range of the head-arm assembly, and provides safe deceleration in the event of an uncontrolled seek.

## (4) Major Specifications

- Force coefficient : 0.11 (kg-m/A)
- Movable section inertia :  $24 \times 10^{-4}$  (kg-m<sup>2</sup>)
- Coil resistance : 10 ( $\Omega$ ) (20°)
- Moving angle : 0.208 (rad)
- Magnetic circuit weight : 2.4 (kg)

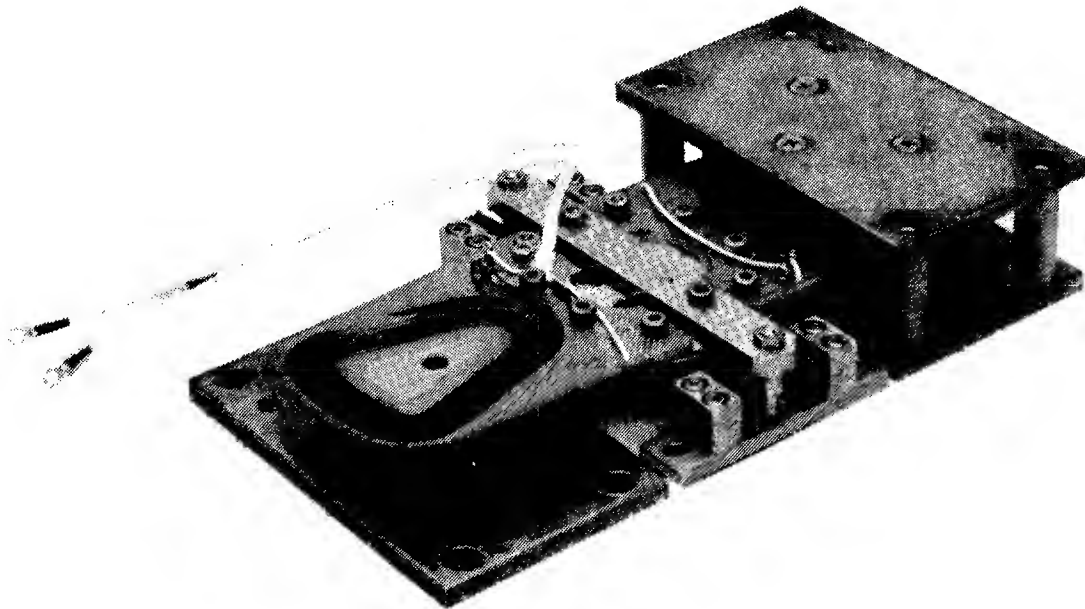


Figure 5.3-3 Outer view of Rotary Actuator

## 5.4 SPINDLE MOTOR

### (1) Features

By adopting the brushless DC spindle motor and connecting the motor directly to the spindle shaft, the following are realized.

- The device becomes compact.
- Pulley and belts are unnecessary, therefore, no maintenance is required.
- Accuracy of rotational speed is improved.
- Vibration is reduced.
- Dynamic braking replaces mechanical brake

### (2) Construction

Construction of the motor is shown in Figure 5.4-1. The rotor poles generate torque by the revolving magnetic field, and are connected directly to a single shaft to which magnetic disks are attached.

The stator winding generates the above mentioned revolving magnetic field by successively switching the current in it.

The rotor pole position detector determines the switching time of the current in the stator winding by detecting the position of rotor poles. The stator winding and rotor pole position detector are fixed in the motor housing, which is fixed on the DE base.

(3) Specification

Table 5.4-1 Specifications

|                                |    |                               |       |
|--------------------------------|----|-------------------------------|-------|
| Output                         | P  | W                             | 120   |
| Rated torque                   | T  | kg-cm                         | 2.7   |
| Rated revolution               | N  | rpm                           | 3,961 |
| Rated Current                  | I  | A                             | 4.0   |
| Induced voltage constant       | Ke | mV/rpm, O/P/phase             | 8.2   |
| Winding resistance             | Ra | $\Omega$ /phase at 20°C       | 1.12  |
| Winding inductance             | La | mH/phase                      | 1.7   |
| Winding phase number           |    |                               | 3     |
| Number of poles and pole pairs | 2P |                               | 4     |
| Position sensor                |    | DN6839<br>Matsushita Electric |       |

The rated values are 3-phase, half drive (for 120° conduction)

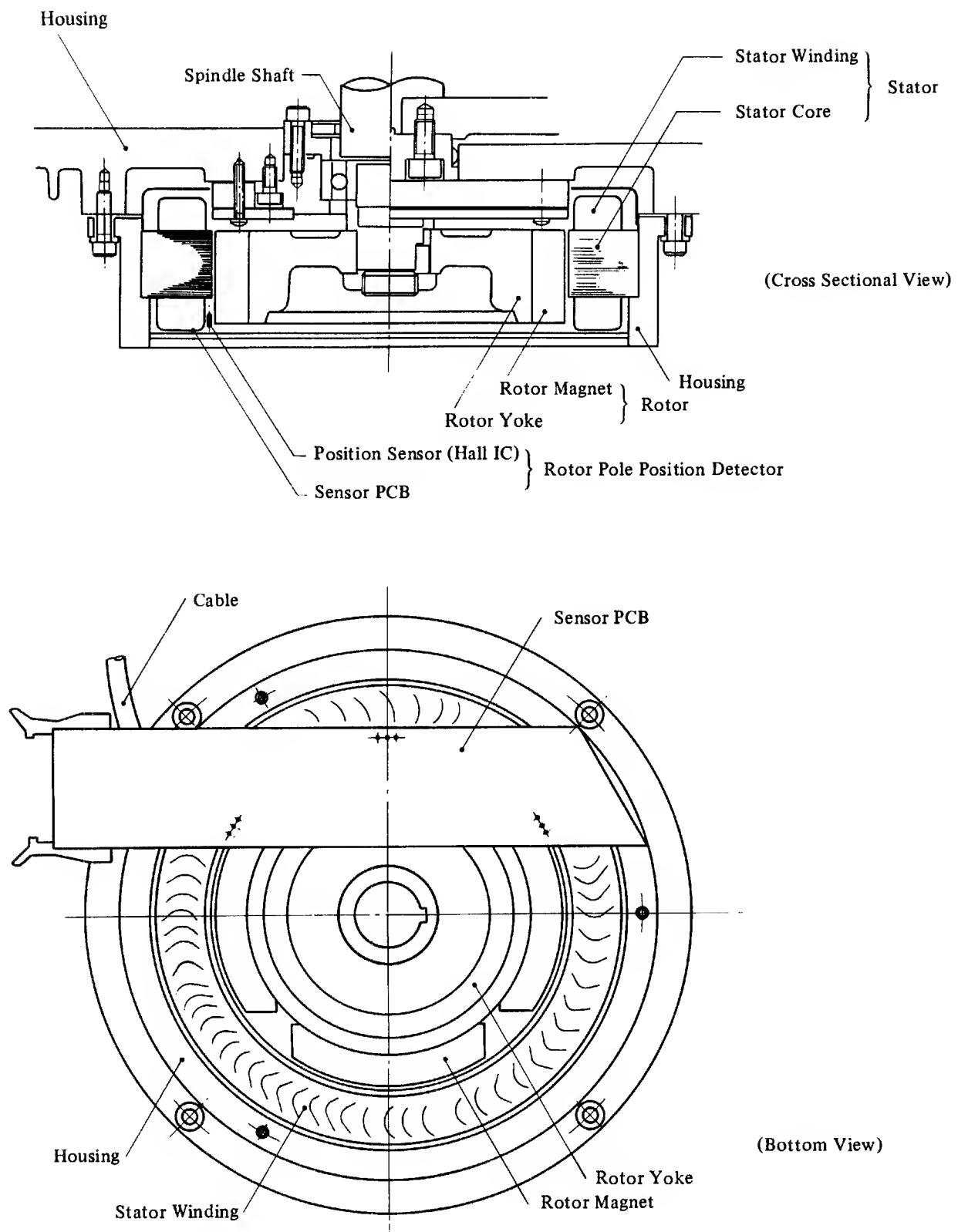


Figure 5.4-1 Construction of the Spindle Motor

#### (4) Principle of Operation

The brushless DC motor is made by replacing brushes and commutators of the ordinary DC motor with a rotor pole position detector and a semiconductor drive circuit. The schematic circuit of the 3-phase half-wave drive used is shown in Figure 5.4-2. The various waveforms when the DC motor is rotating in the regular direction are shown in Figure 5.4-3. Consequently, in an actual drive, the rotational force is obtained by energizing the windings in the order of  $C'-C \rightarrow B'-B \rightarrow A'-A$ .

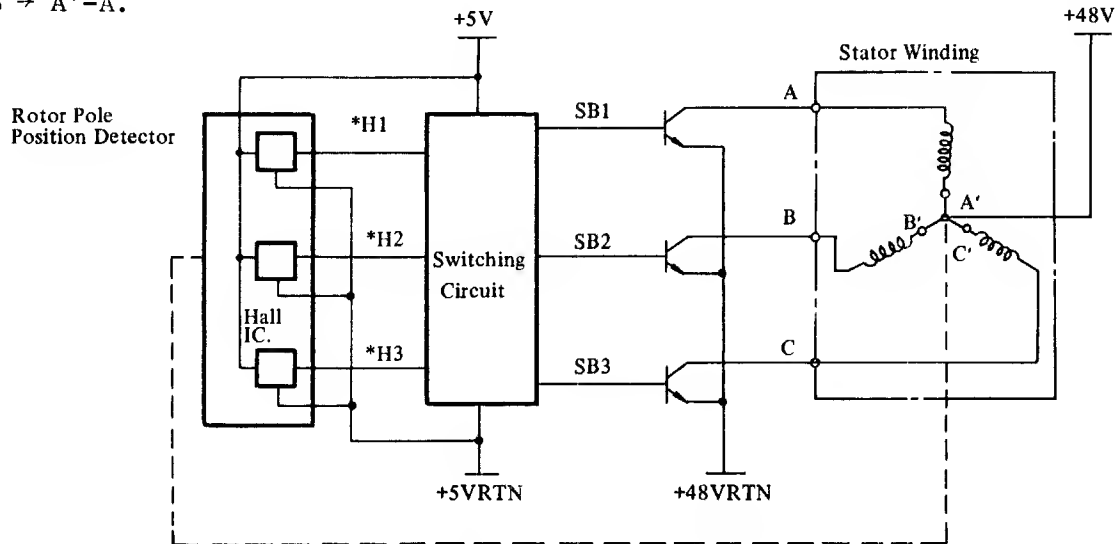


Figure 5.4-2 Schematic Diagram of the Drive Circuit

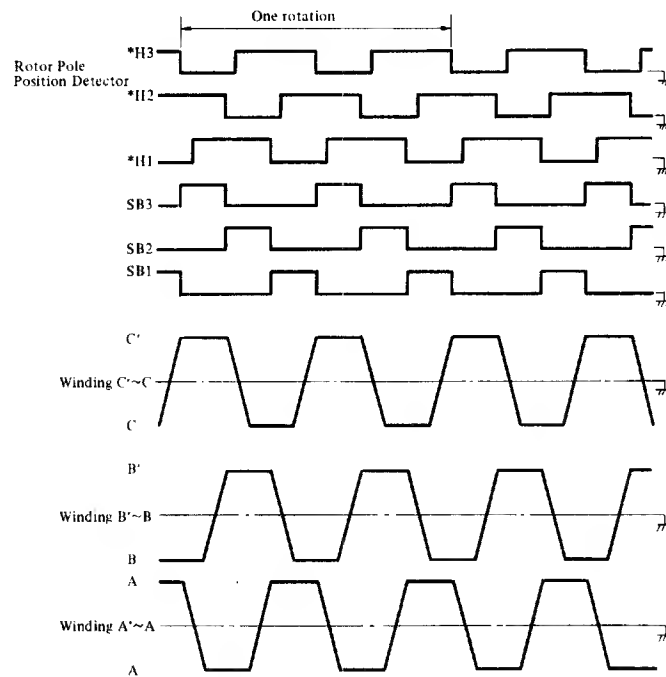


Figure 5.4-3 DC Motor Waveforms



## 5.5 MAGNETIC HEAD AND DISK

### (1) Magnetic Head

To obtain a high recording density, advanced Winchester type CSS (Contact Start and Stop) heads are used for both moving and fixed heads. While the disks are not rotating, the heads rest on the disk surfaces in contact, but when the rotation starts, the heads begin to float over the disk surfaces. After the disks reach the specified rotational speed, the heads maintain the flying height with the balanced force of each load spring and the air-bearing between disk surfaces and the head sliders.

Therefore, to prevent wear caused by contact-start/stop, and to achieve minimum but stable flying height, the head is loaded slightly and its slider rails are tapered.

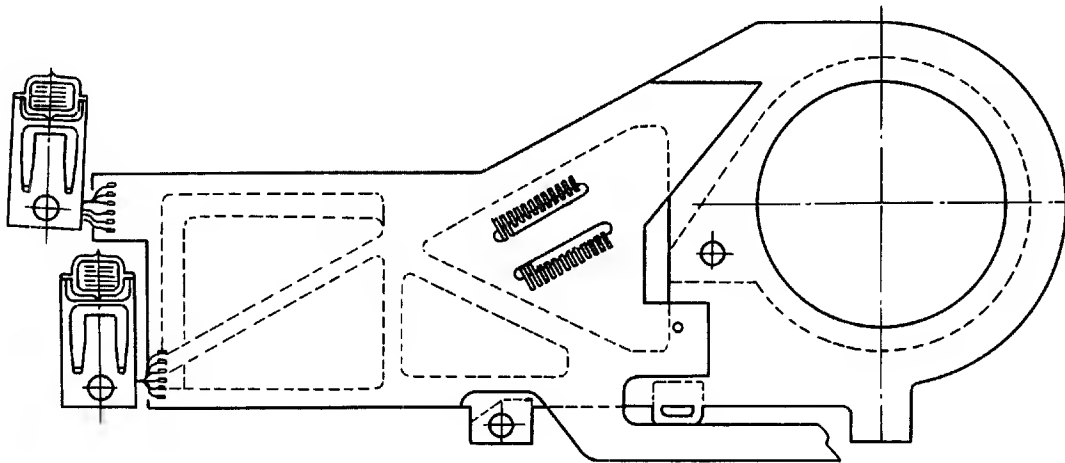


Figure 5.5-1 Moving Head Arm Assembly

There are two kinds of heads, i.e., moving head and fixed head. Both heads have a similar construction, but the moving head has only one Read/Write core whereas fixed head has four Read/Write cores, as shown in Figures 5.5-2 and 5.5-3 respectively. To increase the output voltage at high recording density, the core is made from Mn-Zn instead of Ni-Zn which is the commonly used material.

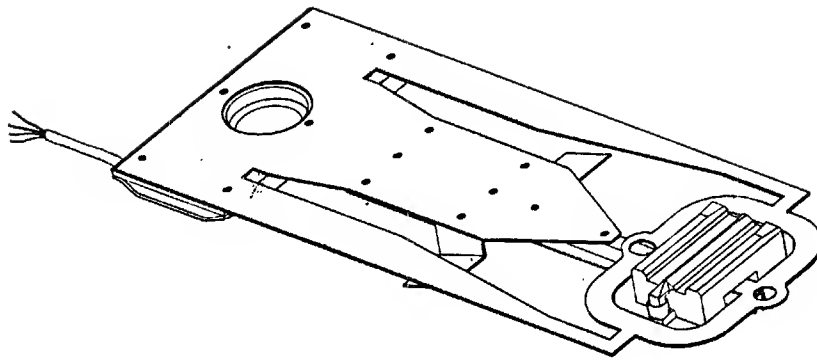


Figure 5.5-2 Moving Head

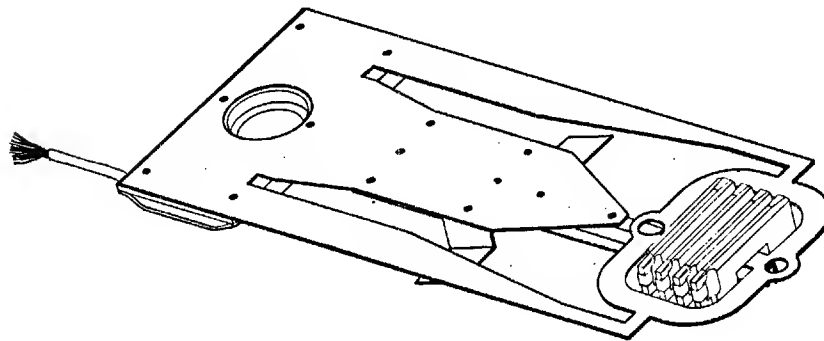


Figure 5.5-3 Fixed Head

## (2) Disk

A magnetic disk has a diameter of 10.5 inches (268 mm) and is made of aluminum on which magnetic material is coated. Special coating is provided on the surface of this magnetic material in order to prevent wear caused by repeated contact-start/stop operations.

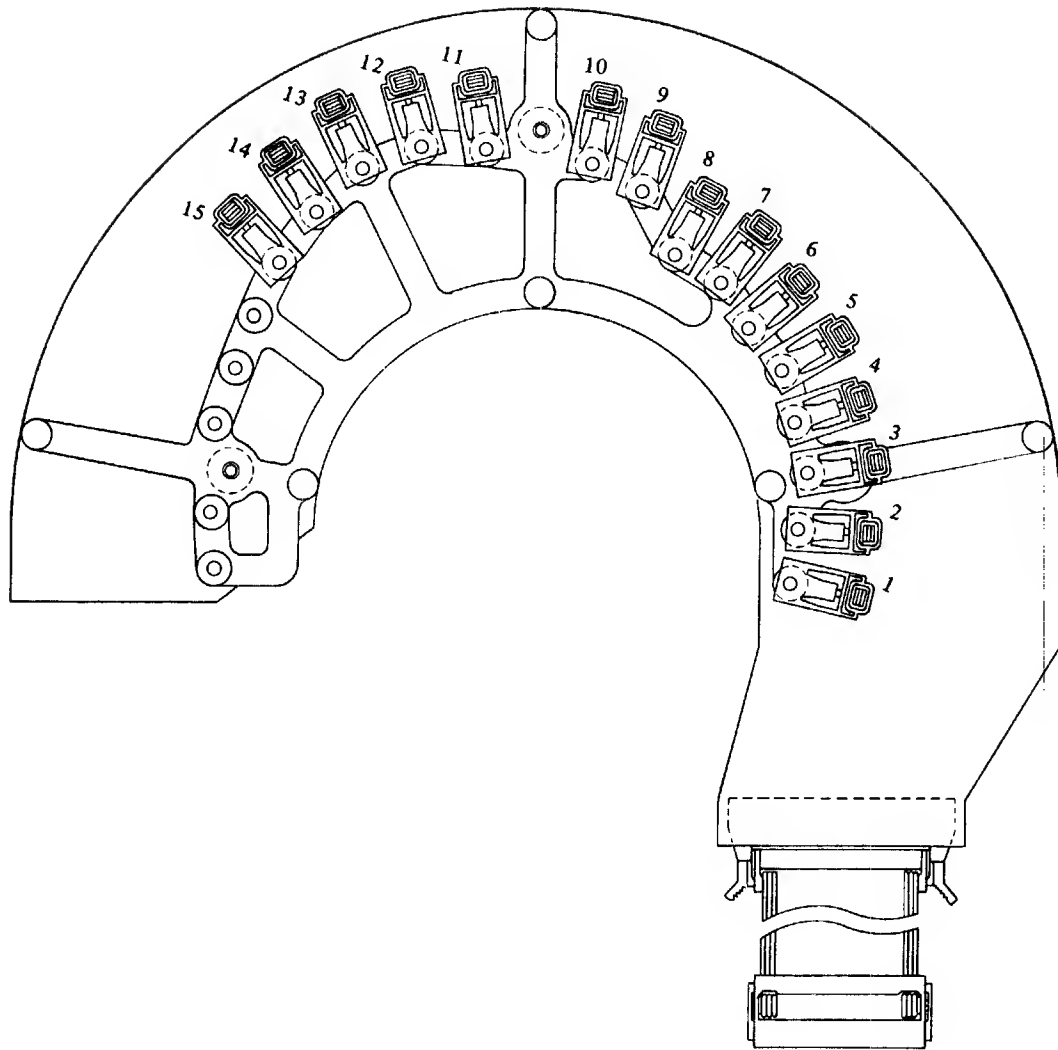
## (3) Fixed Heads Block

Fixed heads are located at the top surface of the disks in the DE of M2351AF. Fifteen sliders having four cores each are attached to a fixed head block. Thus, there are 60 fixed head tracks in all, and are allocated to Cylinder 896 to 898 and Head 0 to 19 respectively.

A PCB with ICs (fifteen head pre-amplifiers and two decoders) is also attached to the block. Input and Output signals are transferred through a flat cable. The construction of the Fixed Head Block and address of each head are shown in Table 5.5-1 and Figure 5.5-4.

Table 5.5-1 Slider No. Vs. Cylinder/Head Address

| Slider No. | Address |         | Slider No. | Address |         | Slider No. | Address |         |
|------------|---------|---------|------------|---------|---------|------------|---------|---------|
|            | CYL     | HD      |            | CYL     | HD      |            | CYL     | HD      |
| 1          | 897     | 08 ~ 11 | 6          | 896     | 08 ~ 11 | 11         | 898     | 00 ~ 03 |
| 2          | 897     | 04 ~ 07 | 7          | 896     | 12 ~ 15 | 12         | 898     | 04 ~ 07 |
| 3          | 897     | 00 ~ 03 | 8          | 896     | 16 ~ 19 | 13         | 898     | 08 ~ 11 |
| 4          | 896     | 00 ~ 03 | 9          | 897     | 12 ~ 15 | 14         | 898     | 12 ~ 15 |
| 5          | 896     | 04 ~ 07 | 10         | 897     | 16 ~ 19 | 15         | 898     | 16 ~ 19 |



Numbers written in the figure denote the slider numbers.

Figure 5.5-4 Fixed Head Block

## 5.6 COOLING SYSTEM

### 5.6.1 Cooling system of early version

The drive is cooled by a centralized cooling system using a line blower. The air is sucked in through the cooling hole of the front panel, passes through air filter, the line blower and the air duct, and is blown uniformly over the entire DE, card cage power amplifier, and interface PCBs. The air which passes over the card cage cools the DC power supply and the air which passes over the DE and the power amplifier cools interface PCBs, and is discharged.

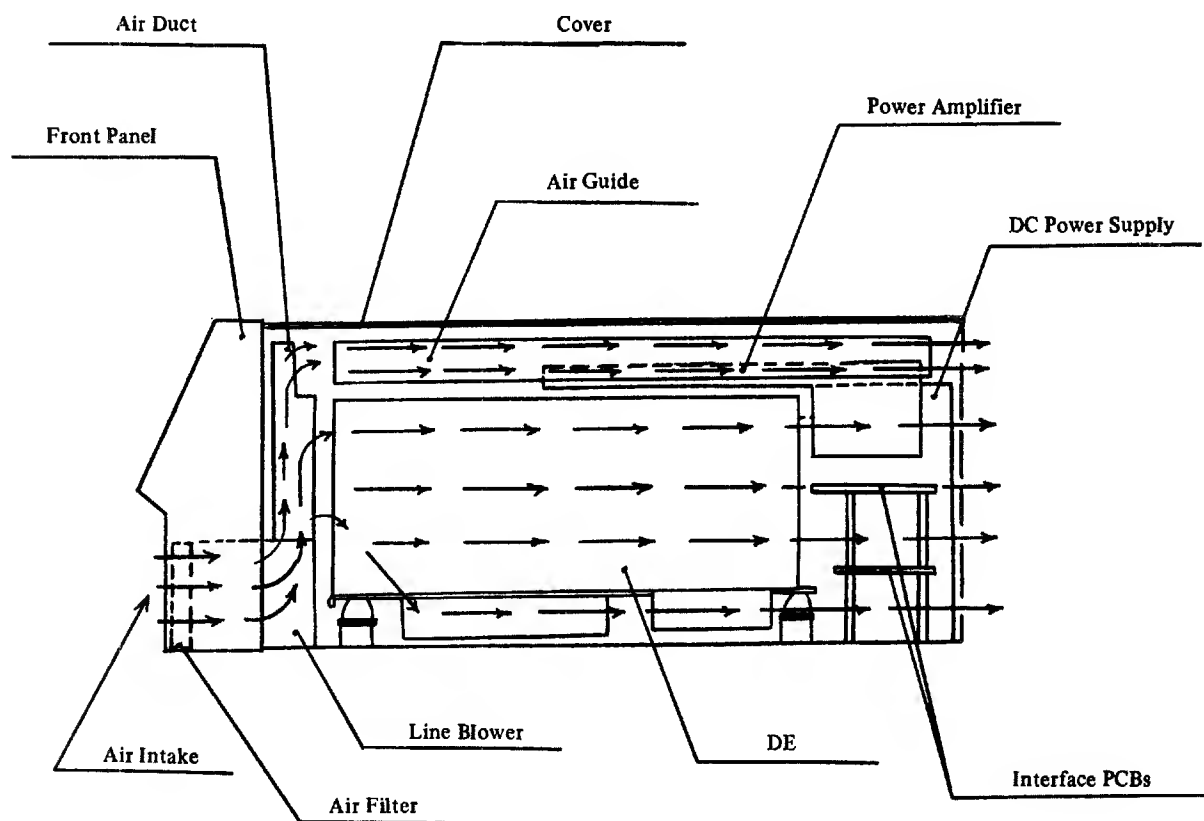


Figure 5.6-1 Air-Flow

### 5.6.2 Cooling system of current version

The drive is cooled by a centralized cooling system using a line blower. The air is sucked in through the cooling slot of the front panel, passes through air filter, the line blower and Power amplifier, and is blown uniformly over the entire DE, card cage, and interface PCBs. The air which passes over the card cage cools the DC power supply and the air which passes over the DE cools interface PCBs, and is discharged.

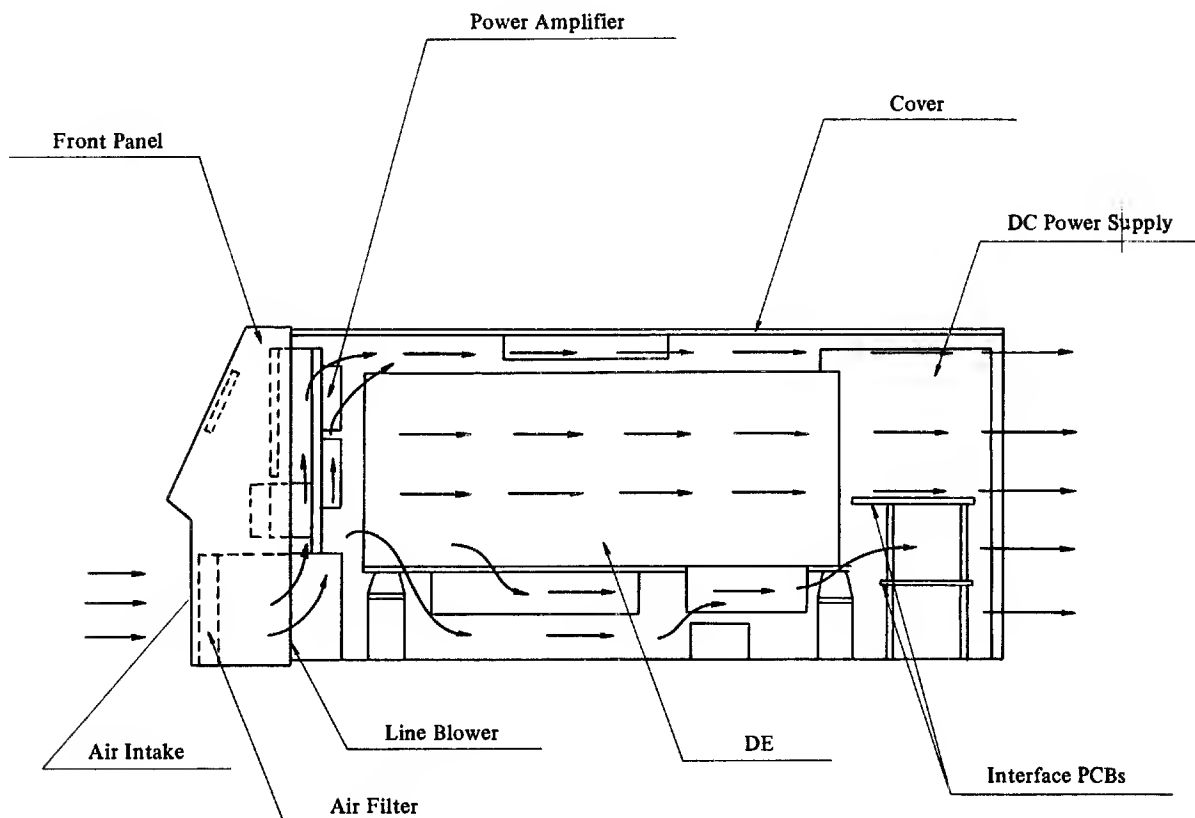


Figure 5.6-2 Air-Flow

## 5.7 ASSEMBLY DRAWINGS

The following drawings illustrate different levels of assembly in the disk drive. Each breakdown is followed by a corresponding table containing an Index No., Quantity, Composition (component parts of the larger assembly), Part Number and Description.

5.7.1 Early version (M2351A:~ #1898)

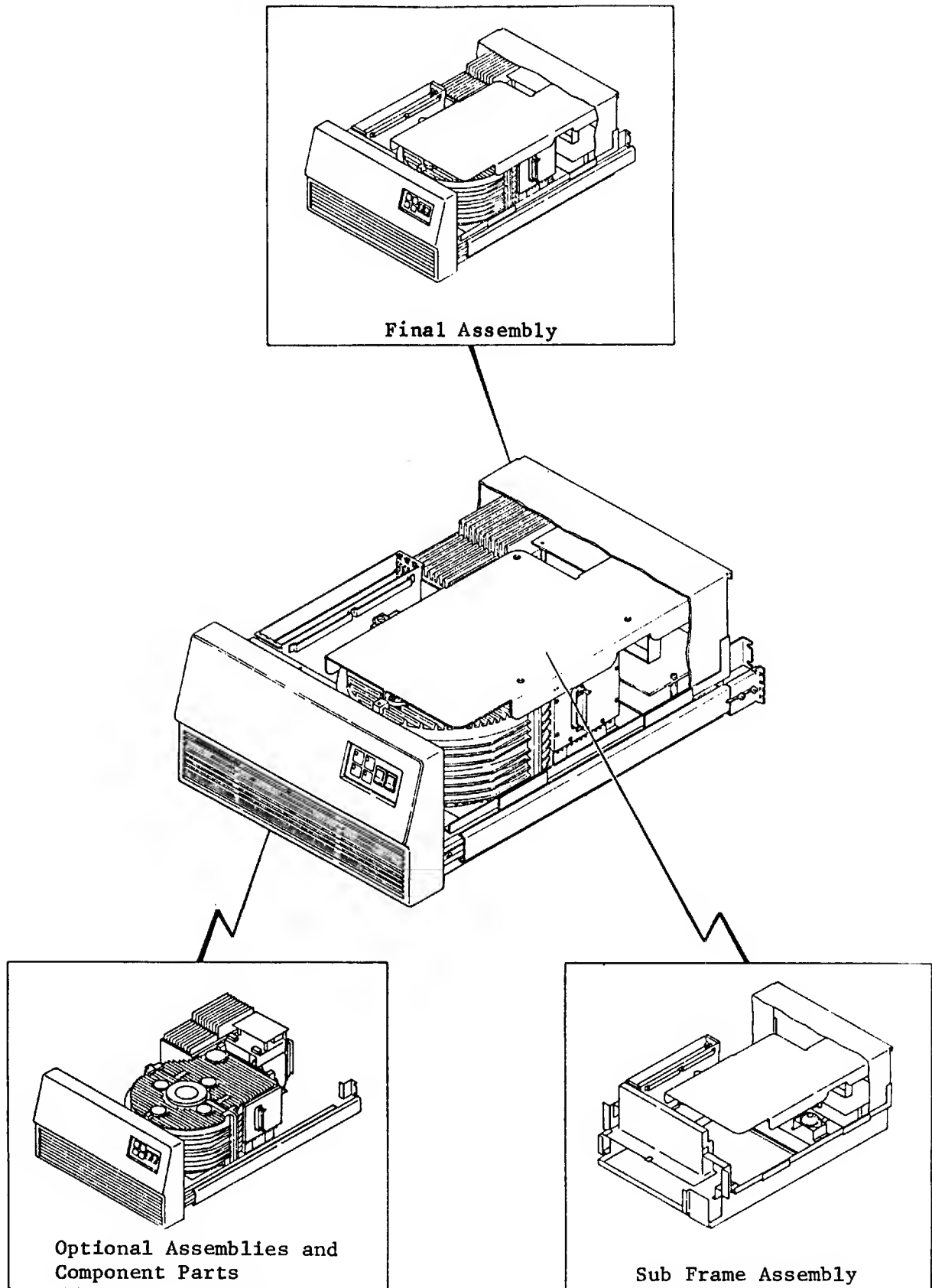


Figure 5.7-1 Visual Index Mini-Disk Drive



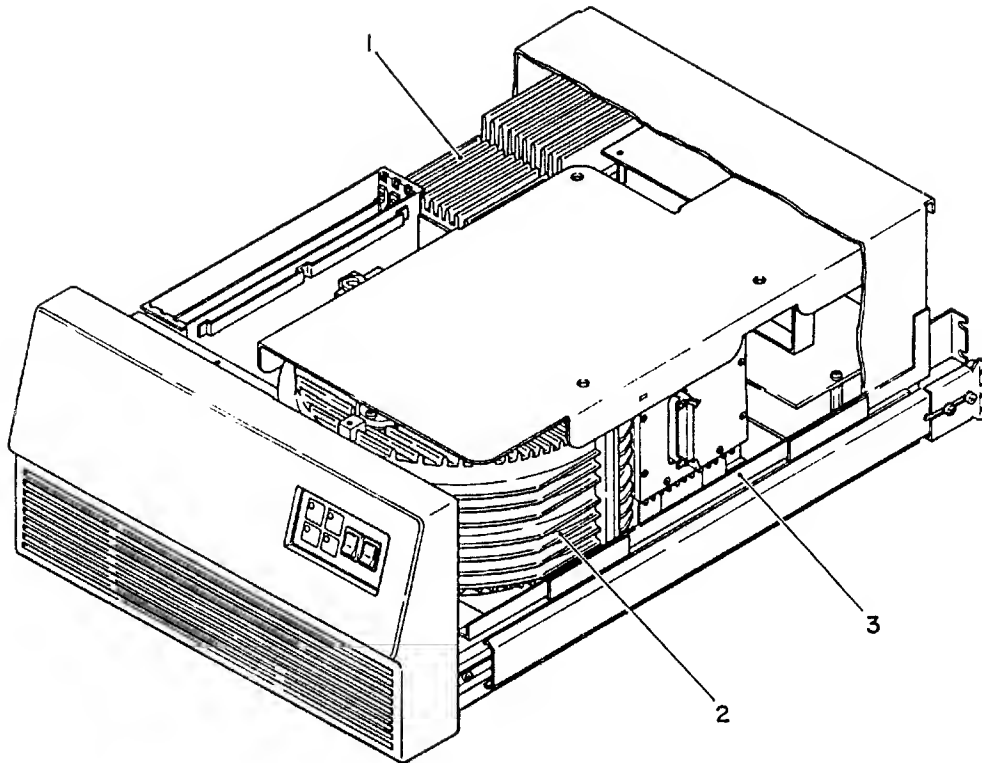


Figure 5.7-2

Table 5.7-1

| Index No. | Composition & Quantity |   |  |  |  |  |  | Part Number     | Description                           |
|-----------|------------------------|---|--|--|--|--|--|-----------------|---------------------------------------|
|           | 1                      |   |  |  |  |  |  | B03B-4655-B002A | M2351A Mini-Disk Drive                |
|           | 1                      |   |  |  |  |  |  | B03B-4655-B003A | M2351AF Mini-Disk Drive               |
| 1         |                        | 1 |  |  |  |  |  | B14L-5105-0073A | DC Power Supply                       |
| 2         |                        | 1 |  |  |  |  |  | B030-4610-T005A | DE Assembly<br>(Non-Fixed Heads Type) |
| 2         |                        | 1 |  |  |  |  |  | B030-4610-T006A | DE Assembly<br>(Fixed Heads Type)     |
| 3         |                        | 1 |  |  |  |  |  | B210-1435-T001A | Sub-Frame Assembly                    |

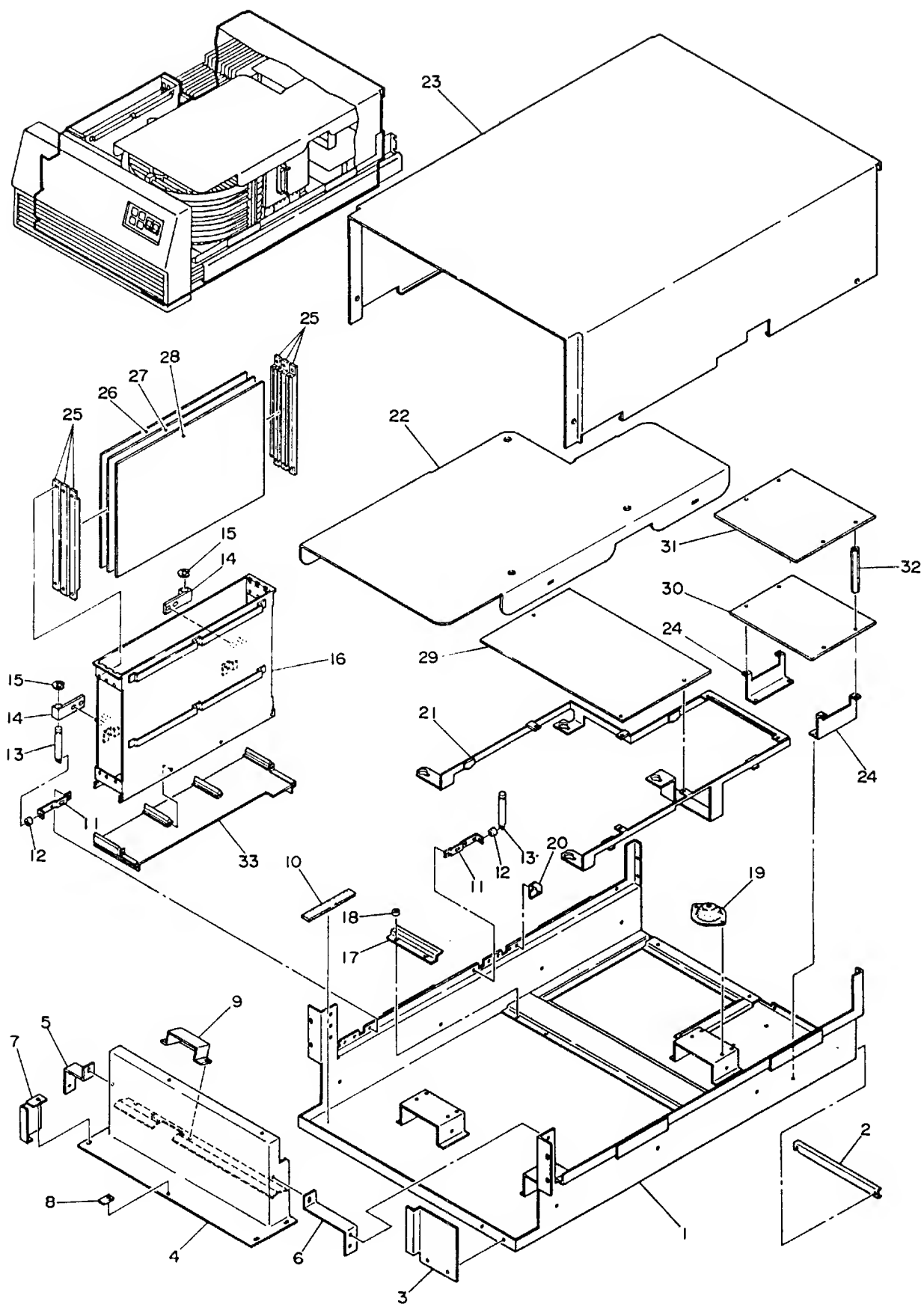


Figure 5.7-3 Sub-Frame Assembly

Table 5.7-2 Sub-Frame Assembly

| Index No. | Composition & Quantity |   |  |  |  |  |  | Part Number          | Description    |
|-----------|------------------------|---|--|--|--|--|--|----------------------|----------------|
|           | 1                      |   |  |  |  |  |  | B210-1435-T001A      | Sub-Frame Assy |
| 1         |                        | 1 |  |  |  |  |  | B210-1435-W001A      | Sub-Frame      |
| 2         |                        | 1 |  |  |  |  |  | B210-1435-X068A      | Cable Pad      |
| -         |                        | 2 |  |  |  |  |  | F6-SBD-4×16S-M-NI1A  | Screw          |
| 3         |                        | 1 |  |  |  |  |  | B210-1435-X037A      | Plate          |
| -         |                        | 2 |  |  |  |  |  | F6-SSA-3×5S-M-NI1A   | Screw          |
| 4         |                        | 1 |  |  |  |  |  | B210-1435-X017A      | Duct           |
| -         |                        | 6 |  |  |  |  |  | F6-SBD-4×6S-M-NI1A   | Screw          |
| 5         |                        | 1 |  |  |  |  |  | B210-1435-X039A      | Plate          |
| 6         |                        | 1 |  |  |  |  |  | B210-1435-X040A      | Plate          |
| -         |                        | 4 |  |  |  |  |  | F6-SSA-3×5S-M-NI1A   | Screw          |
| 7         |                        | 1 |  |  |  |  |  | B210-1435-X070A      | Guide          |
| 8         |                        | 1 |  |  |  |  |  | B210-1435-X071A      | Plate          |
| -         |                        | 1 |  |  |  |  |  | F6-SBD-4×6S-M-NI1A   | Screw          |
| 9         |                        | 1 |  |  |  |  |  | B210-1435-X042A      | Cover          |
| -         |                        | 2 |  |  |  |  |  | F6-SBD-2.5×6S-M-NI1A | Screw          |
| 10        |                        | 2 |  |  |  |  |  | B210-1435-X018A      | Rubber Plate   |
| 11        |                        | 2 |  |  |  |  |  | B210-1435-X056A      | Plate          |
| -         |                        | 6 |  |  |  |  |  | F6-SSA-3×6S-M-NI1A   | Screw          |
| 12        |                        | 2 |  |  |  |  |  | B210-1435-X057A      | Spacer         |
| -         |                        | 2 |  |  |  |  |  | F6-SBD-4×16S-M-NI1A  | Screw          |
| -         |                        | 2 |  |  |  |  |  | F6-N1-4S             | Nut            |
| -         |                        | 2 |  |  |  |  |  | F6-SPK-4×4S          | Spacer         |
| 13        |                        | 2 |  |  |  |  |  | B210-1435-X055A      | Shaft          |
| 14        |                        | 2 |  |  |  |  |  | B210-1435-X058A      | Bearing        |
| -         |                        | 4 |  |  |  |  |  | F6-N1-4S             | Nut            |
| -         |                        | 4 |  |  |  |  |  | F6-WB-4S             | Washer         |
| -         |                        | 4 |  |  |  |  |  | F6-WM-4S             | Washer         |
| 15        |                        | 2 |  |  |  |  |  | F6-ER-6              | Retaining Ring |
| 16        |                        | 1 |  |  |  |  |  | B210-1435-W045A      | Gate Cover     |
| -         |                        | 2 |  |  |  |  |  | F6-SBD-4×10S-M-NI1A  | Screw          |
| -         |                        | 4 |  |  |  |  |  | F6-SBD-4×6S-M-NI1A   | Screw          |
| 17        |                        | 1 |  |  |  |  |  | B210-1435-X053A      | Stopper        |

Table 5.7-2 - continued

| Index No. | Composition & Quantity |   |  |  |  |  | Part Number        | Description                 |
|-----------|------------------------|---|--|--|--|--|--------------------|-----------------------------|
| 18        |                        | 1 |  |  |  |  | B210-1435-X057A    | Spacer                      |
| -         |                        | 2 |  |  |  |  | F6-SBD-4×6S-M-NI1A | Screw                       |
| 19        |                        | 3 |  |  |  |  | B30L-1150-0003A    | Damper                      |
| -         |                        | 6 |  |  |  |  | F6-SBD-4×6S-M-NI1A | Screw                       |
| 20        |                        | 1 |  |  |  |  | B210-1435-X054A    | Plate                       |
| -         |                        | 2 |  |  |  |  | F6-SSA-3×6S-M-NI1A | Screw                       |
| 21        |                        | 1 |  |  |  |  | B210-1435-W048A    | Frame                       |
| 22        |                        | 1 |  |  |  |  | B210-1435-X074A    | Cover                       |
| 23        |                        | 1 |  |  |  |  | B210-1435-X024A    | Cover                       |
| 24        |                        | 2 |  |  |  |  | B210-1435-X049A    | Plate                       |
| -         |                        | 4 |  |  |  |  | F6-SSA-3×6S-M-NI1A | Screw                       |
| -         |                        | 3 |  |  |  |  | F6-BA-8×12-M-ZN1A  | Bolt (for DE Assembly)      |
| -         |                        | 2 |  |  |  |  | F6-SBD-4×6S-M-NI1A | Screw (for DC Power Supply) |
| -         |                        | 8 |  |  |  |  | F6-SBD-4×6S-M-NI1A | Screw (for Slide Guide)     |
| 25        | 6                      |   |  |  |  |  | C980-3010-X031     | Card Guide                  |
| 26        | 1                      |   |  |  |  |  | C16B-5510-0010#U   | Servo Circuit               |
| 27        | 1                      |   |  |  |  |  | C16B-5123-0980#U   | Logic Circuit               |
| 28        | 1                      |   |  |  |  |  | C16B-5500-0990#U   | Read Amplifier              |
| 29        | 1                      |   |  |  |  |  | B16-8130-0010A#U   | Power Amplifier             |
| 30        | 1                      |   |  |  |  |  | B16-8140-0010A#U   | Interface Circuit           |
| -         | 1                      |   |  |  |  |  | B03B-4655-0100A    | Dual Channel (Option)       |
| 31        |                        | 1 |  |  |  |  | B16B-8150-0010A#U  | Interface Circuit           |
| 32        |                        | 4 |  |  |  |  | F6-KKB1-3×70       | Stud                        |
| 33        | 1                      |   |  |  |  |  | B16B-8160-0010A#U  | Back Panel                  |

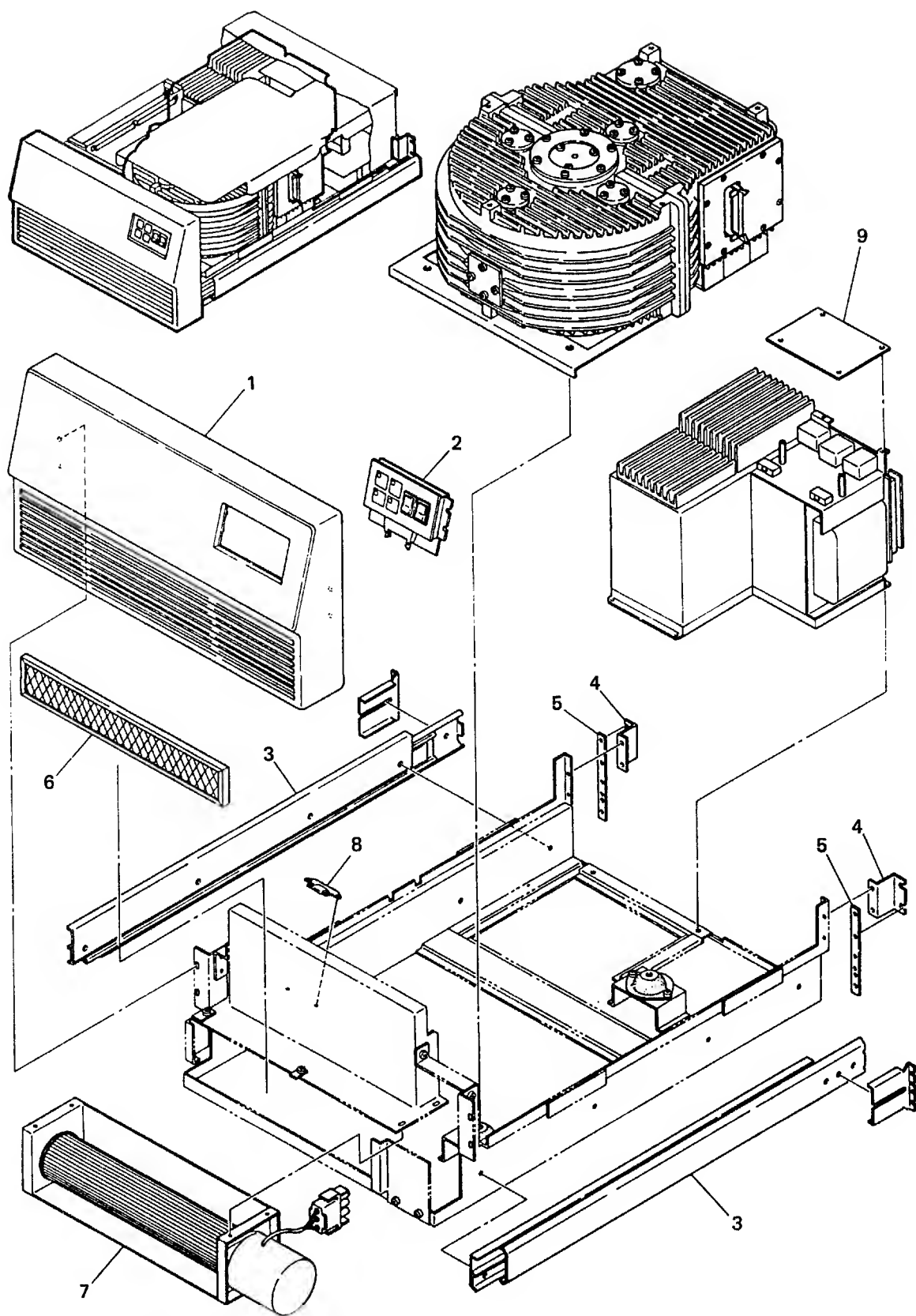


Figure 5.7-4 Optional Assemblies and Component Parts

Table 5.7-3 Optional Assemblies and Component Parts

| Index No. | Composition & Quantity |    |  |  |  |  |  | Part Number       | Description       |          |
|-----------|------------------------|----|--|--|--|--|--|-------------------|-------------------|----------|
| 1         | 1                      |    |  |  |  |  |  | B250-2150-X163A   | Front Panel       |          |
| 2         | 1                      |    |  |  |  |  |  | N860-3346-T001    | Operator Panel    |          |
|           | 1                      |    |  |  |  |  |  | B030-4655-V100A   | Slide Guide       |          |
| 3         |                        | 1  |  |  |  |  |  | B27L-0230-0010A   | Slide Guide       | (Option) |
| 4         |                        | 2  |  |  |  |  |  | B210-1435-X902A   | Metal Fitting     |          |
| 5         |                        | 4  |  |  |  |  |  | B210-1435-X903A   | Plate             |          |
| -         |                        | 20 |  |  |  |  |  | F6-SW2NA-5×10S    | Screw with Washer |          |
| 6         | 1                      |    |  |  |  |  |  | B90L-0400-0303A   | Air Filter        |          |
| 7         | 1                      |    |  |  |  |  |  | B90L-1200-0101A   | Line Blower       |          |
| 8         | 1                      |    |  |  |  |  |  | B57L-0040-0003A   | Fan Alarm         |          |
| 9         | 1                      |    |  |  |  |  |  | B16B-7830-0010A#U | Indicator Unit    |          |

5.7.2 CURRENT VERSION (M2351A: #1899-, M2351AF: #1-)

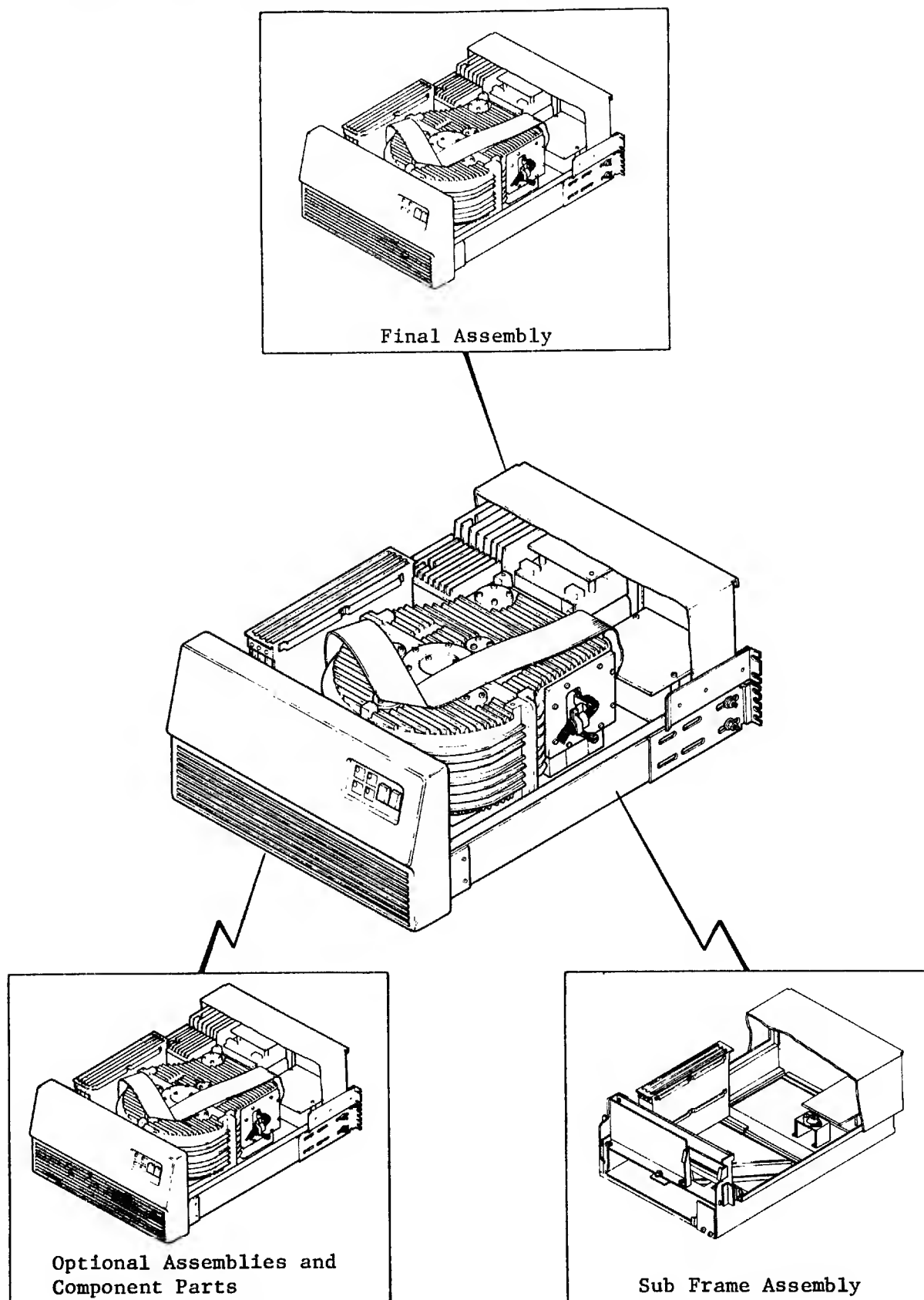


Figure 5.7-5 Visual Index Mini-Disk Drive

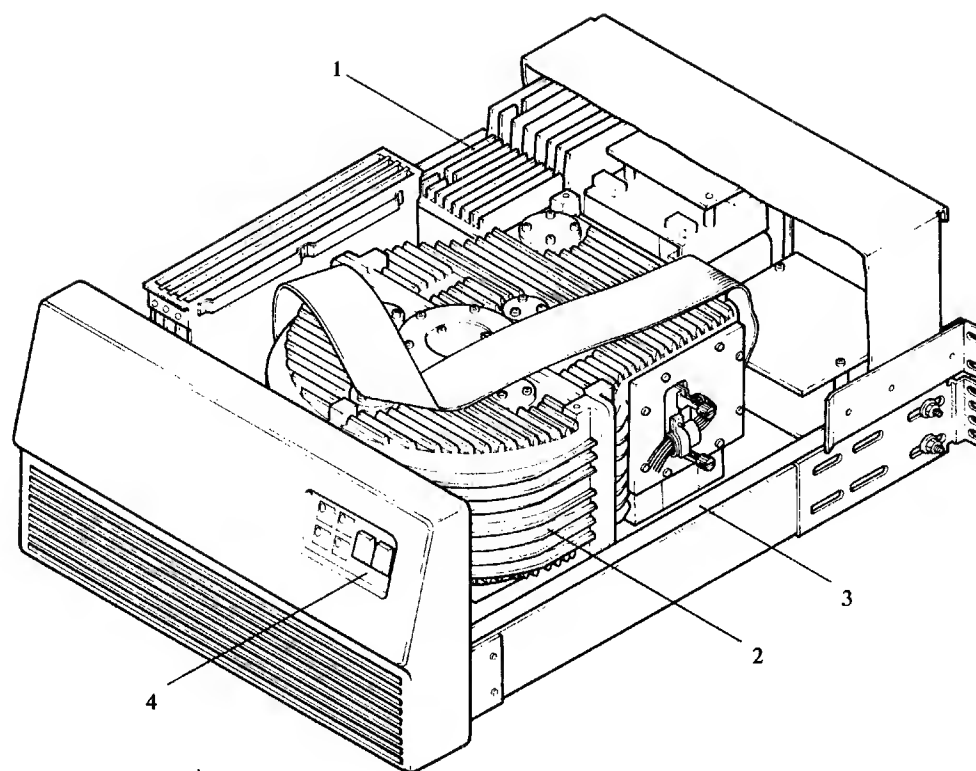


Figure 5.7

Table 5.7-4

| Index No. | Composition & Quantity |  |  |  |  |  |  | Specifications  | Description                           |
|-----------|------------------------|--|--|--|--|--|--|-----------------|---------------------------------------|
|           | 1                      |  |  |  |  |  |  | B03B-4655-B002A | M2351A Mini-Disk Drive                |
|           | 1                      |  |  |  |  |  |  | B03B-4655-B003A | M2351AF Mini-Disk Drive               |
| 1         | 1                      |  |  |  |  |  |  | B14L-5105-0073A | DC Power Supply                       |
| 2         | 1                      |  |  |  |  |  |  | B030-4610-T007A | DE Assembly<br>(Non-Fixed Heads Type) |
| 2         | 1                      |  |  |  |  |  |  | B030-4610-T008A | DE Assembly<br>(Fixed Heads Type)     |
| 3         | 1                      |  |  |  |  |  |  | B210-1435-T002A | Sub-Frame Assembly                    |
| 4         | 1                      |  |  |  |  |  |  | N860-3346-T001  | Operator Panel                        |



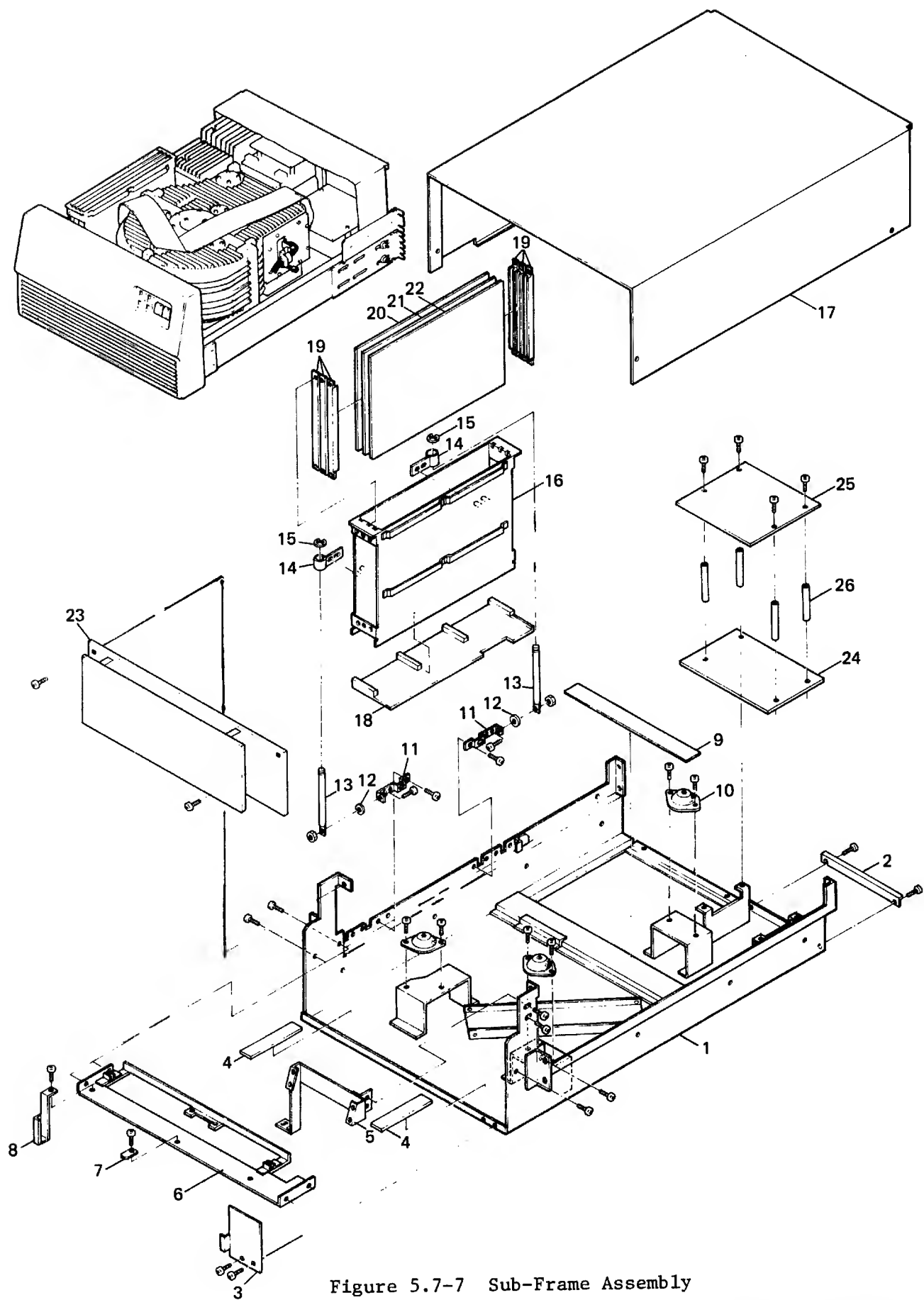


Figure 5.7-7 Sub-Frame Assembly

Table 5.7-5 Sub-Frame Assembly

| Index No. | Composition & Quantity |   |   |  |  |  | Specifications      | Description             |
|-----------|------------------------|---|---|--|--|--|---------------------|-------------------------|
|           | 1                      |   |   |  |  |  | B210-1435-T002A     | Sub-Frame Unit          |
| 1         |                        | 1 |   |  |  |  | B210-1435-W101A     | Sub-Frame Assy          |
| 2         |                        | 1 |   |  |  |  | B210-1435-X068A     | Cable Pad               |
| -         |                        | 2 |   |  |  |  | F6-SW2NA-4×20S      | Screw                   |
| 3         |                        | 1 |   |  |  |  | B210-1435-X912A     | Guide (right side)      |
| -         |                        | 2 |   |  |  |  | F6-SSA-3×5S-M-NI1A  | Screw                   |
| 4         |                        | 2 |   |  |  |  | B210-1435-X112A     | Rubber Plate            |
| 5         |                        | 1 |   |  |  |  | B210-1435-W115A     | Bracket                 |
| -         |                        | 4 |   |  |  |  | F6-SW2NA-4×8S       | Screw                   |
| 6         |                        | 1 |   |  |  |  | B210-1435-W110A     | Plate                   |
| -         |                        | 4 |   |  |  |  | F6-SSA-3×6S-M-NI1A  | Screw                   |
| 7         |                        | 1 |   |  |  |  | B210-1435-X071A     | Plate                   |
| -         |                        | 1 |   |  |  |  | F6-SW2NA-4×8S       | Screw                   |
| 8         |                        | 1 |   |  |  |  | B210-1435-X911A     | Guide (left side)       |
| -         |                        | 1 |   |  |  |  | F6-SW2NA-4×8S       | Screw                   |
| 9         |                        | 1 |   |  |  |  | B210-1435-X122A     | Packing                 |
| 10        |                        | 3 |   |  |  |  | B30L-1150-0003A     | Damper                  |
|           |                        | 1 |   |  |  |  | B210-1435-W055A     | Hinge Assy (left side)  |
|           |                        | 1 |   |  |  |  | B210-1435-W056A     | Hinge Assy (right side) |
| 11        |                        |   | 1 |  |  |  | B210-1435-X056A     | Plate                   |
| 12        |                        |   | 1 |  |  |  | B210-1435-X057A     | Spacer                  |
| -         |                        |   | 1 |  |  |  | F6-SBD-4×16S-M-NI1A | Screw                   |
| -         |                        |   | 1 |  |  |  | F6-N1-4S            | Nut                     |
| -         |                        |   | 1 |  |  |  | F6-SPK-4×4S         | Spacer                  |
| 13        |                        |   | 1 |  |  |  | B210-1435-X055A     | Shaft                   |
| 14        |                        |   | 1 |  |  |  | B210-1435-X058A     | Plate                   |
| 15        |                        |   | 1 |  |  |  | F6-ER-6             | Retaining Ring          |
| 16        |                        | 1 |   |  |  |  | B210-1435-W045A     | Gate Cover              |
| -         |                        | 4 |   |  |  |  | F6-N1-4S            | Nut                     |
| -         |                        | 4 |   |  |  |  | F6-WB-4S            | Washer                  |
| -         |                        | 4 |   |  |  |  | F6-WM-4S            | Washer                  |

Table 5.7-5 - continued

| Index No. | Composition & Quantity |   |  |  |  |  | Specifications     | Description                 |
|-----------|------------------------|---|--|--|--|--|--------------------|-----------------------------|
| 17        |                        | 1 |  |  |  |  | B210-1435-W120G    | Cover                       |
| -         |                        | 2 |  |  |  |  | F6-SSA-3×6S-M-N11A | Screw                       |
| -         |                        | 2 |  |  |  |  | F6-SW2NA-4×8S      | Screw                       |
| 18        | 1                      |   |  |  |  |  | B16B-8160-0010A#U  | Back Panel PCB (BQGMU)      |
| 19        | 6                      |   |  |  |  |  | C980-3010-X031     | Card Guide                  |
| 20        | 1                      |   |  |  |  |  | C16B-5501-0010#U   | Servo PCB (SVIAU)           |
| 21        | 1                      |   |  |  |  |  | C16B-5123-0980#U   | Logic PCB (512398U)         |
| 22        | 1                      |   |  |  |  |  | C16B-5500-0990#U   | R/W PCB (RFJAU)             |
| 23        | 1                      |   |  |  |  |  | B16B-8800-0010A#U  | Power Amplifier PCB (TVKMU) |
| 24        | 1                      |   |  |  |  |  | B16B-8140-0010A#U  | Interface PCB (DQEMU)       |
|           | 1                      |   |  |  |  |  | B03B-4655-0100A    | Dual Channel Option         |
| 25        |                        | 1 |  |  |  |  | B16B-8150-0010A#U  | Interface PCB (DQFMU)       |
| 26        |                        | 4 |  |  |  |  | F6-KKB1-3×70       | Stud                        |

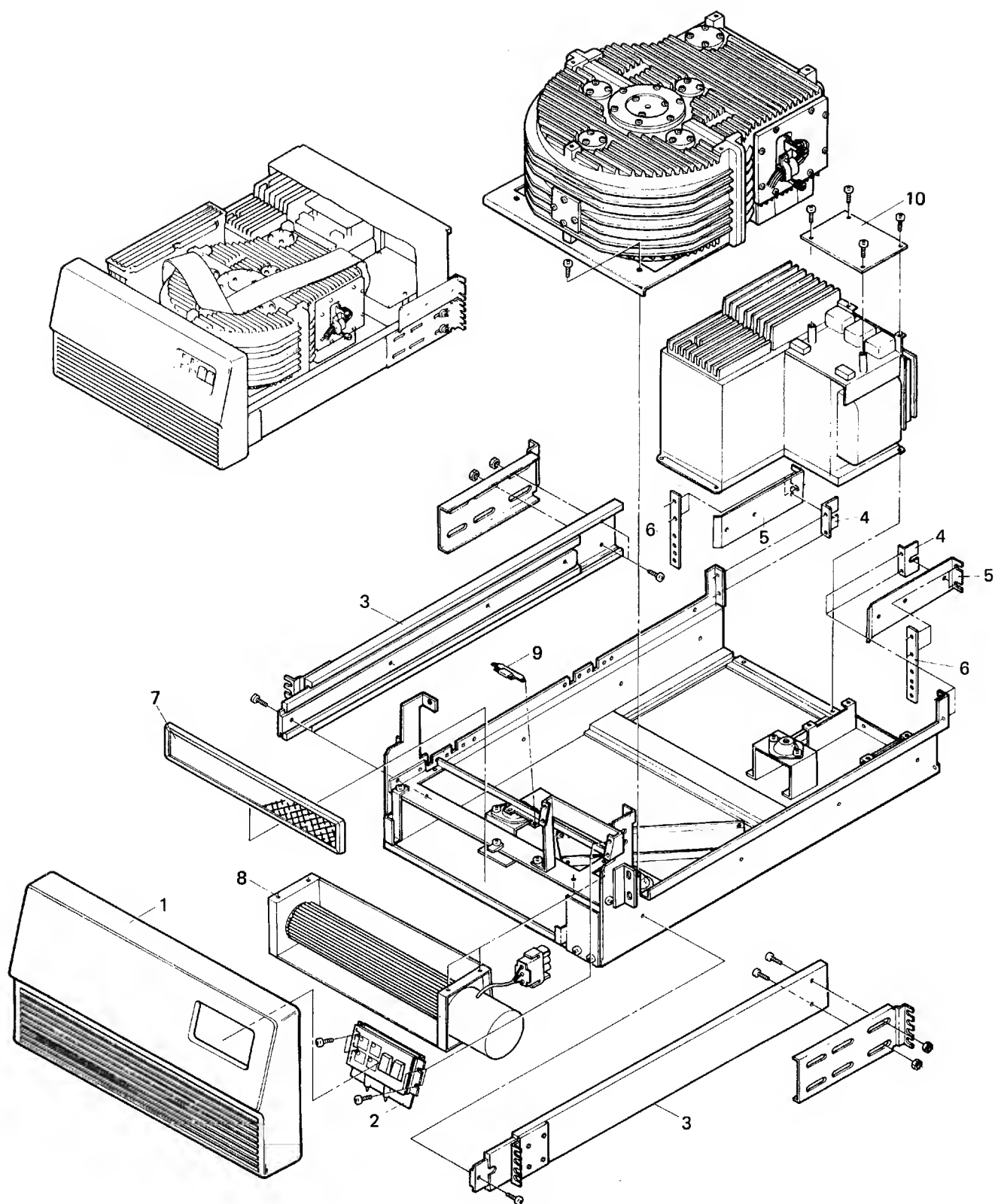


Figure 5.7-8 Optional Assemblies and Component Parts

Table 5.7-8 Optional Assemblies and Component Parts

| Index No. | Composition & Quantity |    |  |  |  |  |  | Specifications    | Description           |
|-----------|------------------------|----|--|--|--|--|--|-------------------|-----------------------|
| 1         | 1                      |    |  |  |  |  |  | B210-1435-X012A   | Front Panel           |
| 2         | 1                      |    |  |  |  |  |  | N860-3346-T001    | Operator Panel        |
|           | 1                      |    |  |  |  |  |  | B030-4655-V100A   | Slide Guide Assy      |
| 3         |                        | 1  |  |  |  |  |  | B27L-0230-0010A   | Slide Guide (Option)  |
| 4         |                        | 2  |  |  |  |  |  | B210-1435-X908A   | Metal Fitting         |
| 5         |                        | 2  |  |  |  |  |  | B210-1435-X909A   | Guide Plate           |
| 6         |                        | 4  |  |  |  |  |  | B210-1435-X903A   | Plate                 |
| -         |                        | 20 |  |  |  |  |  | F6-SW2NA-5×10S    | Screw                 |
| 7         | 1                      |    |  |  |  |  |  | B90L-0400-0303A   | Air Filter            |
| 8         | 1                      |    |  |  |  |  |  | B90L-1200-0101A   | Line Blower           |
| 9         | 1                      |    |  |  |  |  |  | B57L-0040-0003A   | Fan Alarm             |
| 10        | 1                      |    |  |  |  |  |  | B16B-7830-0010A#U | Indicator PCB (HGAMU) |

## CHAPTER 6 DATA FORMAT

The M2351A/AF can be used with two different formats, i.e., Variable Sector Format and Fixed Sector Format, as determined by the controller. The former contains a 3-Byte DC erased area called an Address Mark (AM) prior to each Address Area (AA) indicating the beginning of a record. Therefore, Data Area (DA) with different lengths in a track can be written or read. On the other hand, every record must have the same data area length (governed by sector length) in the Fixed Sector Format.

### 6.1 FORMAT

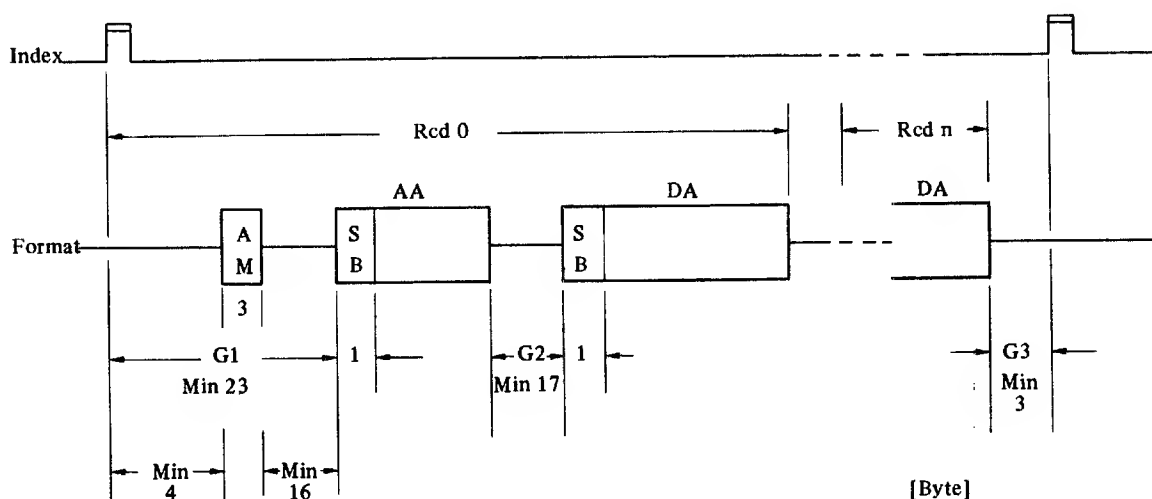


Figure 6.1-1 Variable Sector Format

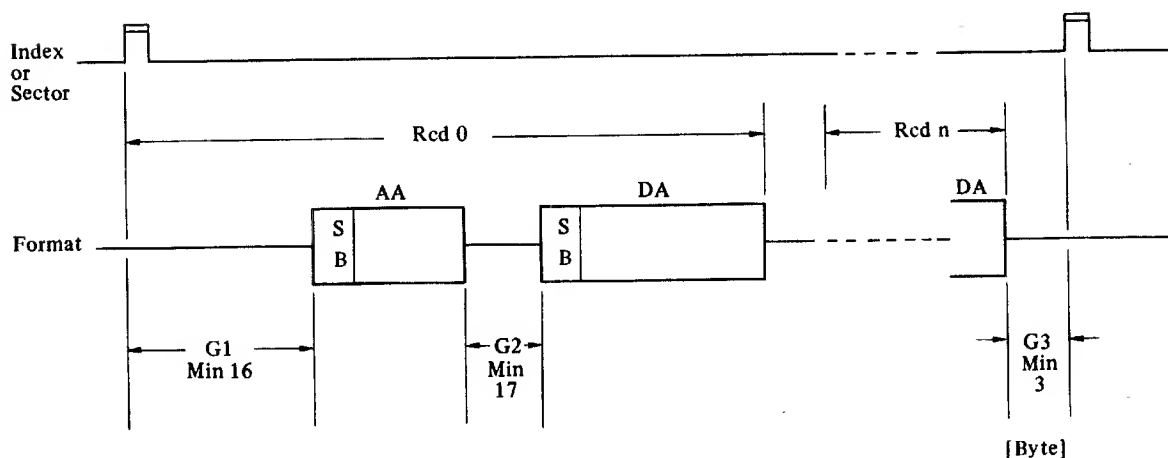


Figure 6.1-2 Fixed Sector Format

## Description of Format Parameters

### -- G1, G2, G3 (Gap 1, 2 and 3)

Gaps between adjacent areas. They must be filled with all '0's.

### -- SB (Sync Byte Pattern)

Indicates the beginning of Address or Data Area.

The pattern for both areas can be varied but the recommended pattern is  $(19)_{16}$  or  $(0E)_{16}$ .

### -- AA (Address Area)

The Address Area should contain the following information:

- Flag Byte to indicate various conditions of the track or sector, i.e., Primary/Alternate track/Sector, Good/Bad track/Sector
- Logical Drive Address
- Cylinder Address
- Head Address
- Sector Address or Record Number
- CRC to check whether the address area information has been read correctly or ECC to correct the address area information when a data error has been detected.

### -- DA (Data Area)

The area where data should be recorded. CRC or ECC should be added. CRC or ECC fields for the data area must be included in the count of bytes selected for the DA.

## 6.2 TRACK EFFICIENCY

Table 6.2-1 shows examples of calculated results of track efficiency in Variable and Fixed Sector Formats. The following assumptions are made for this calculation.

- . The length of Address Area including the SB is 8 Bytes.
- . All gap lengths used are the shortest in Figures 6.1-1 and 6.1-2.
- . The length of the data area is determined using the formula.

$$\begin{aligned} \text{Data Area} &= \text{SB} + \text{DL (Data Length)} + \text{CRC (2 Bytes)} \\ &= 1 + \text{DL} + 2 = \text{DL} + 3 \text{ (Bytes)} \end{aligned}$$

$$\text{Efficiency} = \frac{\text{DL} \times (\text{Sector/Track})}{28,160 \text{ (Bytes/Track)}} \times 100 \quad (\%)$$

Table 6.2-1 Track Efficiency

|                              | DL(B)             | 256  | 512  | 1,024 | 2,048 |
|------------------------------|-------------------|------|------|-------|-------|
| Variable<br>Sector<br>Format | Sector/Track      | 90   | 49   | 26    | 13    |
|                              | Efficiency<br>(%) | 81.8 | 89.0 | 94.5  | 94.5  |
| Fixed<br>Sector<br>Format    | Sector/Track      | 92   | 50   | 26    | 13    |
|                              | Efficiency<br>(%) | 83.6 | 90.9 | 94.5  | 94.5  |



### 6.3 MEDIA SPECIFICATIONS

The quality of all tracks are checked, and location and length of media flaws which may affect the reliability of stored data are recorded in the Header Areas of all tracks before the shipment of a drive from the factory.

By using this media defect information to trigger techniques such as sector/track deallocation or skip displacement, recording data over known media flaws can be avoided.

#### (1) Definition of Track Quality

Every track is classified into three grades dependent on number of defects on a track. They are:

Perfect track : A track containing no defects

Good track : A track containing one defect

Defective track: A track containing two or more defects, or a track containing flaws which may contribute to missing AM or false AM.

If the track is defective, the high order bit of the first cylinder byte in the Header Area is set to one. (Ref. Figure 6.3-1)

Here, defect is defined as media flaws grouped by the maximum flaw length of 64 bytes. 65 bytes of media flaws are treated as two defects, as an example.

#### (2) Quality Standards of Media at Shipment

- The number of defects per DE  $\leq$  500
- The number of defective tracks per DE  $\leq$  30
- Head 0 and 1 at cylinder 0 are perfect tracks
- There is at least one perfect track and no defective tracks at cylinder 841
- All tracks in fixed-heads area are not defective
- If there is a defect in the region of bytes 14-55 after the index mark, there is no defect in the region of bytes 69-164.
- If there is a defect in the region of bytes 56-104 after the index mark, there is no defect in the region of bytes 14-55 and 116-164.

A DE which does not meet these standards is rejected at its shipment.

### (3) Header Format

The Header format is divided into two parts. The first part of the format is a Fixed Sector Format, and the second part is a Variable Sector Format. The Fixed Sector Format information is normally included in the first 56 bytes following the index mark. The Variable Sector Format information consists of 49 bytes and normally follows the Fixed Sector information.

Following are rules for the defect recording:

- The position of a defect is listed in bytes (Hex.) after the index mark, +/- 1 byte.
- The length of a defect is in bits (Hex.) +/- 1 bit.
- Unused defect locations are all zeros.
- Every track is recorded with this defect format whether defects exist or not.
- More than one defect on a track causes the track to be flagged as a defective track. The first four media defects on the track are logged.

Figure 6.3-1 shows the format when there are no defects in the first 105 bytes after the index mark.

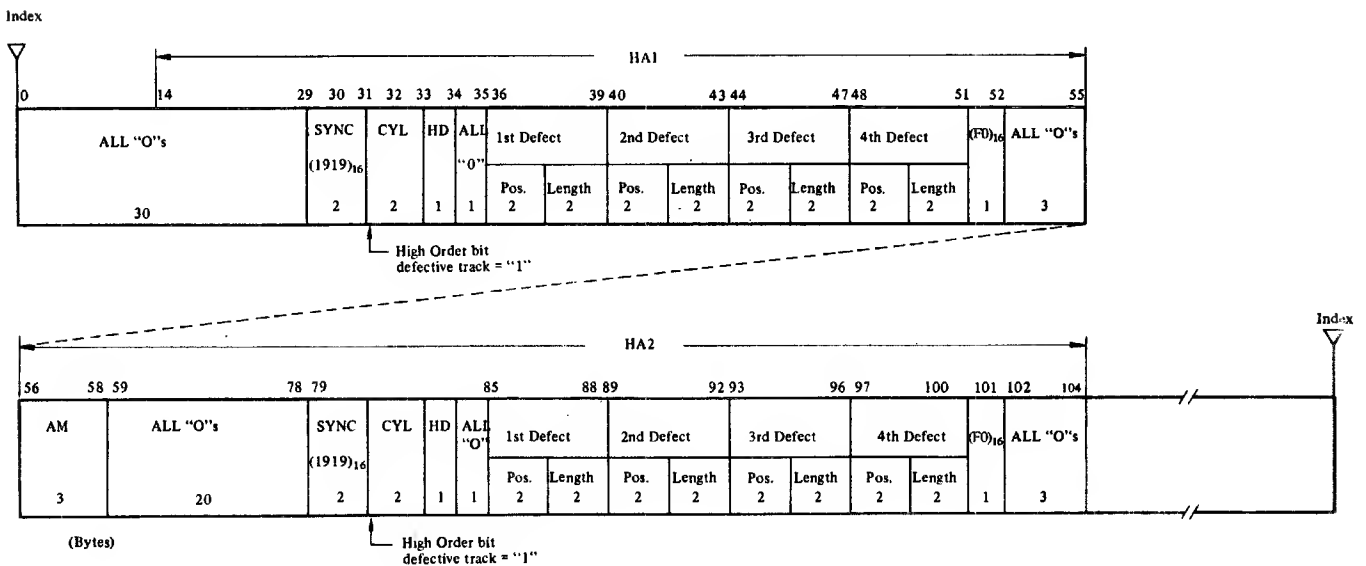


Figure 6.3-1 Format 1

If the beginning of a defect is located in the region of bytes 14 - 55, 60 bytes of zeros are added to Gap 1. Figure 6.3-2 shows an example of this format.

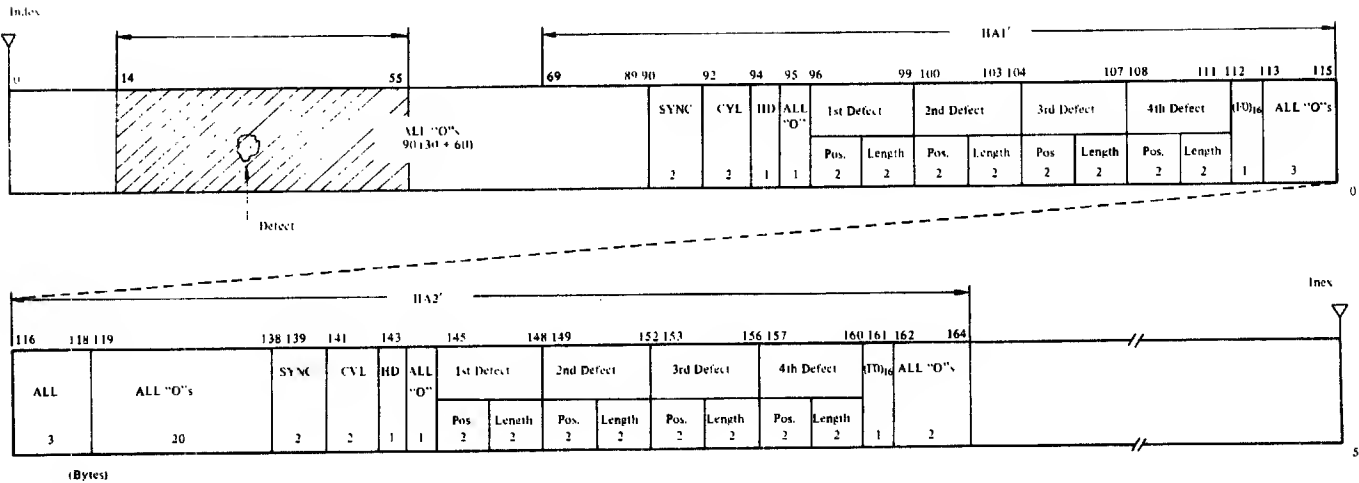


Figure 6.3-2 Format 2

If a defect is located in the region of bytes 56 - 104, the gap before the address mark is increased to 60 bytes. Figure 6.3-3 shows an example of this format.

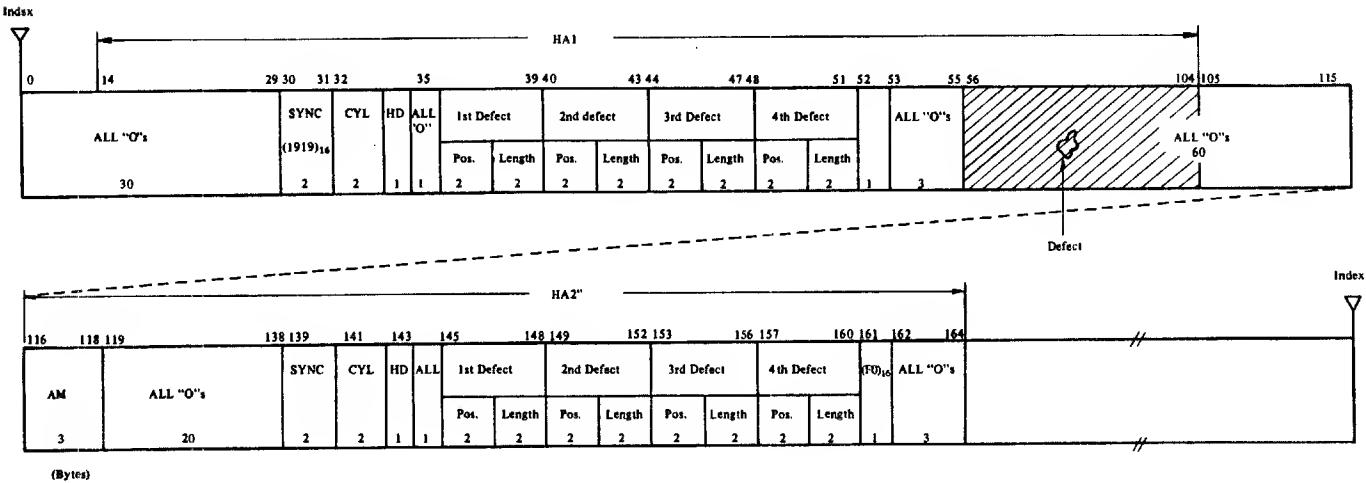


Figure 6.3-3 Format 3

In Figure 6.3-2 and 6.3-3, it is guaranteed that there are no defects in the regions where HA1 and HA2 are newly relocated due to a defect.

#### (4) Inspection Data Sheet

The location and length of media flaws are recorded in Header Areas as described in (3), as well as printed out on a sheet which is attached to each drive.

The contents of this sheet are listed below.

- Date (Year: Month: Day)
  - Drive type (M2351A/M2351AF)
  - Serial number of drive
  - DE type (Non-fixed/Fixed head type)
  - Serial number of DE
  - Information about flaws
    - Cylinder address
    - Head address
    - Location of flaws in bytes after index mark
    - Length of flaws in bits
  - Defective track address (Cylinder/Head address)
  - Every perfect head address at cylinder 841
- 'Refer to printout below'

#### MEDIA DEFECT LIST

Date 9/19/84

Model: M2351A#R Serial No.: 15991 De Type: Non De Serial No.: PN46W6T27

| NO. | CYLINDER  | HEAD   | POS/BYTES   | LEN/BITS  |      |
|-----|-----------|--------|-------------|-----------|------|
| 1   | 0001( 1)  | 09( 9) | 3DC2(15810) | 0003( 3)  | 0000 |
| 2   | 0002( 2)  | 0A(10) | 3278(12920) | 0009( 9)  | 0000 |
| 3   | 0003( 3)  | 0A(10) | 3277(12919) | 0011( 17) | 0000 |
| 4   | 0004( 4)  | 04( 4) | 269A( 9882) | 0002( 2)  | 0000 |
| 5   | 0006( 6)  | 0C(12) | 5D90(23952) | 0005( 5)  | 0000 |
| 6   | 0006( 6)  | 0E(14) | 3418(13336) | 0002( 2)  | 0000 |
| 7   | 0006( 6)  | 10(16) | 59F4(23028) | 0002( 2)  | 0000 |
| 8   | 000A( 10) | 10(16) | 019C( 412)  | 0003( 3)  | 0000 |
| 9   | 0011( 17) | 11(17) | 38A4(14500) | 0002( 2)  | 0000 |
| 10  | 0013( 19) | 10(16) | 32A4(12964) | 0003( 3)  | 0000 |
| 11  | 0014( 20) | 10(16) | 587C(22652) | 0005( 5)  | 0000 |
| 12  | 0017( 23) | 09( 9) | 32AD(12973) | 0002( 2)  | 0000 |
| 13  | 0017( 23) | 0F(15) | 518F(20879) | 0002( 2)  | 0000 |
| 14  | 0019( 25) | 03( 3) | 1C1B( 7195) | 0003( 3)  | 0000 |
| 15  | 0019( 25) | 0A(10) | 6A13(27155) | 0003( 3)  | 0000 |
| 16  | 0020( 32) | 11(17) | 34FB(13563) | 0003( 3)  | 0000 |
| 17  | 0022( 34) | 10(16) | 5B76(23414) | 0002( 2)  | 0000 |
| 18  | 0028( 40) | 10(16) | 1C91( 7313) | 0003( 3)  | 0000 |
| 19  | 002A( 42) | 11(17) | 1D98( 7576) | 0002( 2)  | 0000 |
| 20  | 002D( 45) | 12(18) | 4E60(20064) | 0004( 4)  | 0000 |
| 21  | 0030( 48) | 03( 3) | 51A7(20903) | 0006( 6)  | 0000 |
| 22  | 0034( 52) | 0C(12) | 1A10( 6672) | 0002( 2)  | 0000 |
| 23  | 0038( 56) | 0C(12) | 420E(16910) | 0003( 3)  | 0000 |
| 24  | 0039( 57) | 03(03) | 1157( 4439) | 0002( 2)  | 0000 |
| 25  | 003A( 58) | 0C(12) | 48FD(18685) | 0002( 2)  | 0000 |



## CHAPTER 7 INTERFACE

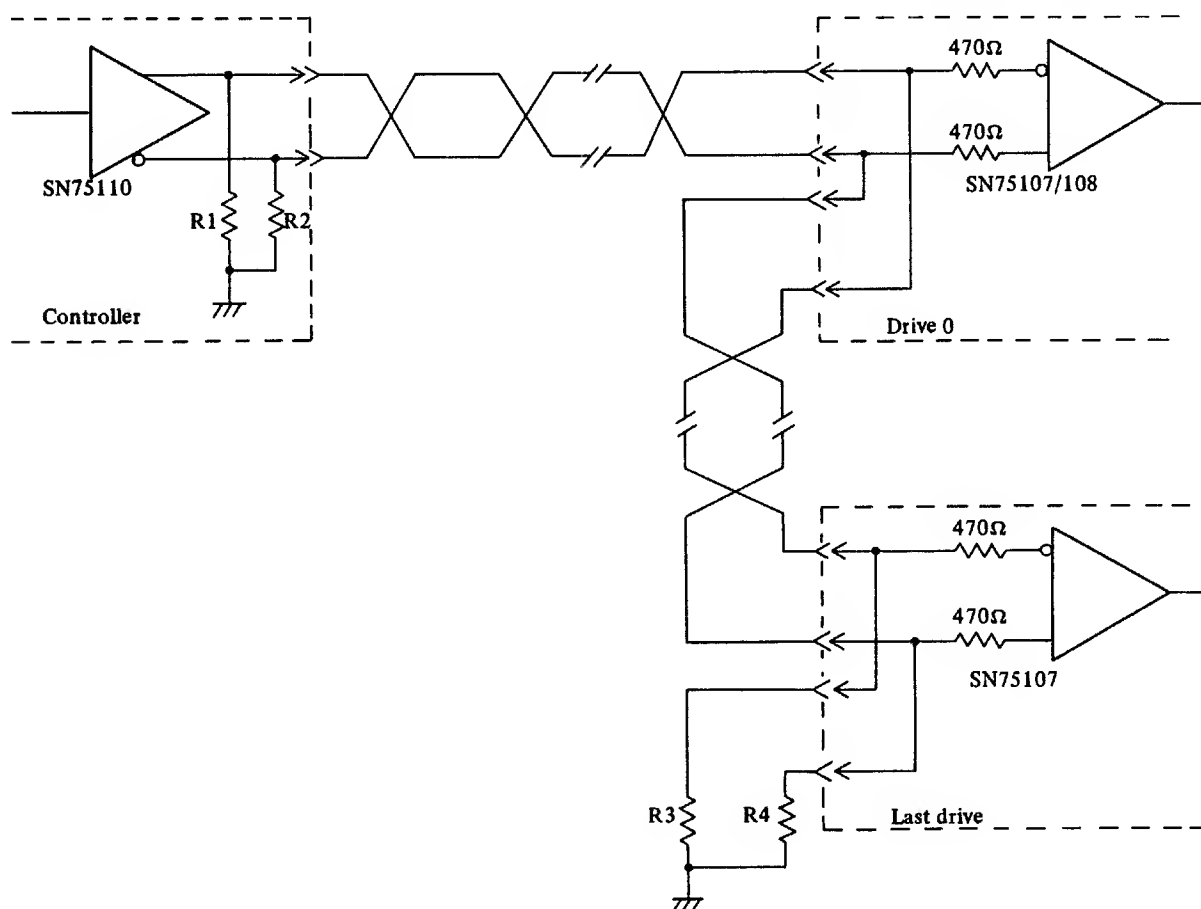
This chapter describes the physical and logical specifications of interface signals between the M2351A/AF and any controller.

### 7.1 SIGNAL TRANSMISSION DRIVER/RECEIVER

SN75110 Drivers and SN75107/108 Receivers are used to provide a terminated and balanced transmission system.

#### (1) A-Cable

All signals except Open Cable Detect and Power Sequence Pick/Hold signals must be terminated both in the drive and the controller as shown in Figure 7.1-1.



- Note; (1) Line terminators are located in the drive and the controller.  
R1 to R4; 56 Ohms $\pm$ 10%.1/10W.  
(2) The maximum cable length is 100 FT (30 m).

Fig. 7.1-1 Balanced Transmission of A-Cable

For the Open Cable Detect signal, two drivers of SN75110 would be required in parallel without termination to increase the drive current in the interface cable as shown in Figure 7.1-2.

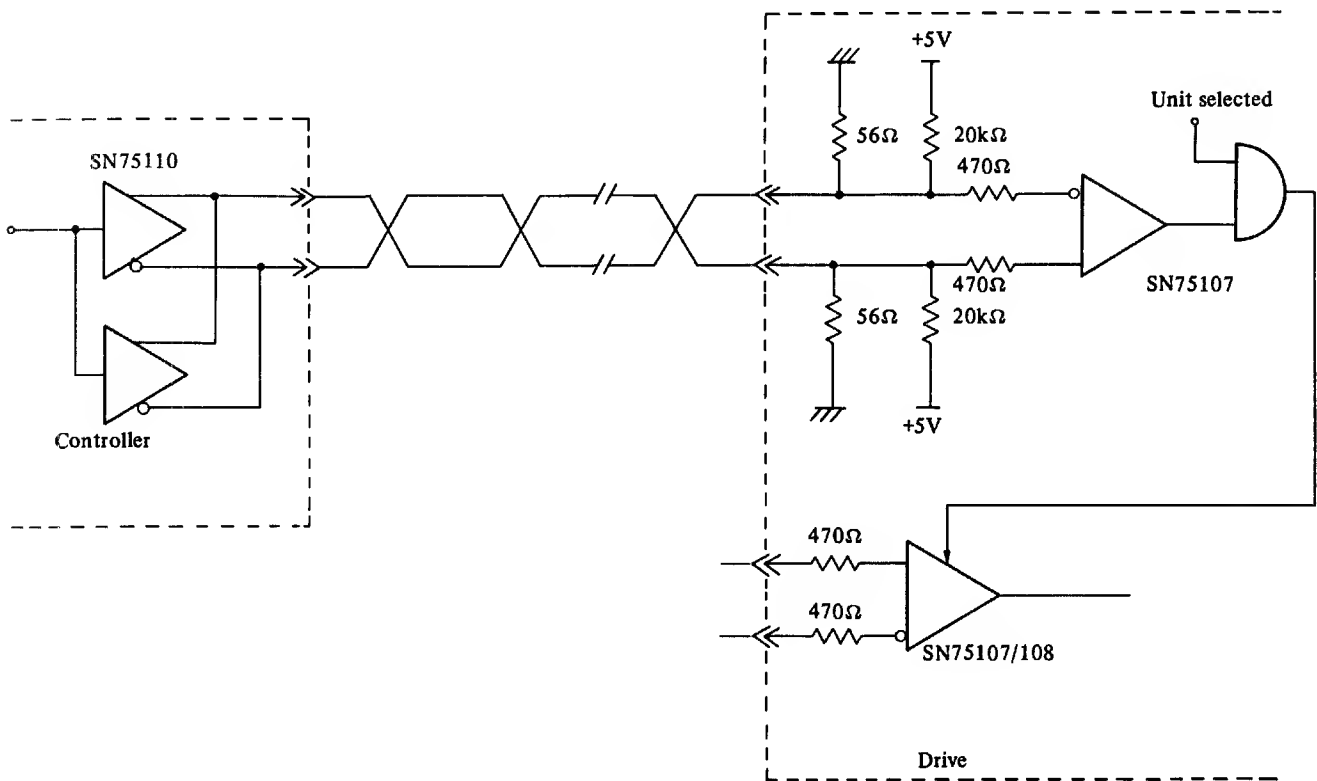


Fig. 7.1-2 Open Cable Detect

Power Sequence Pick and Hold must be set to ground in the controller.

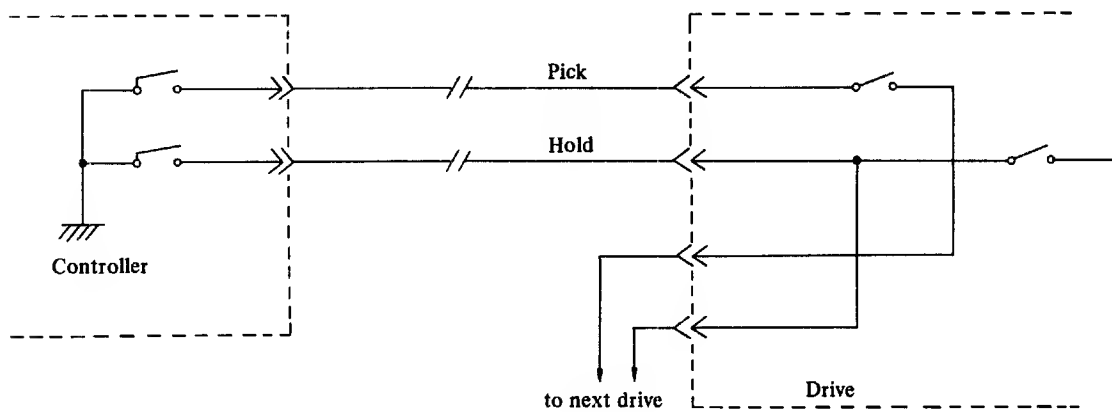
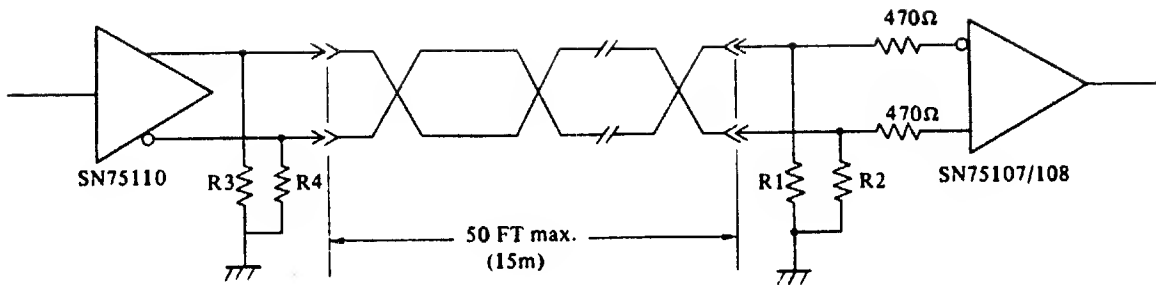


Fig. 7.1-3 Power Sequence Pick/Hold

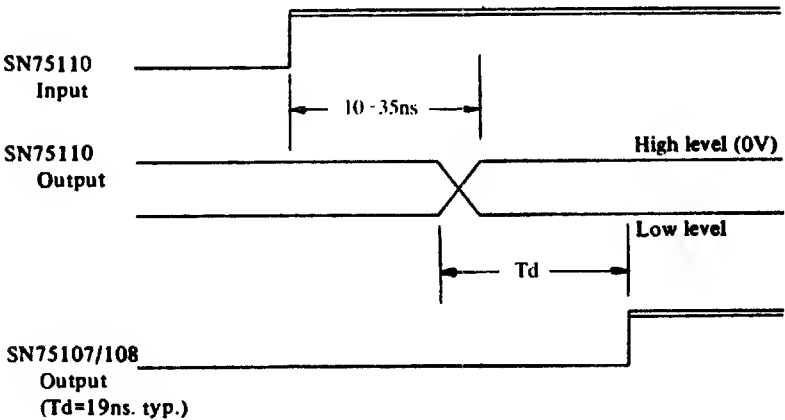
(2) B-Cable



Note; (1) Line terminators are located in the drive and the controller. R1 to R4; 82 Ohms $\pm$ 5%.1/10W.

Fig. 7.1-4 Balanced Transmission of B-Cable

(3) Input/Output Characteristics of Driver/Receiver



Typical output level of SN75110

|            | A-cable | B-cable |
|------------|---------|---------|
| High level | 0V      |         |
| Low level  | -0.33V  | -0.49V  |

Fig. 7.1-5 Input/Output Characteristics



## 7.2 PIN ASSIGNMENT OF INTERFACE CONNECTORS

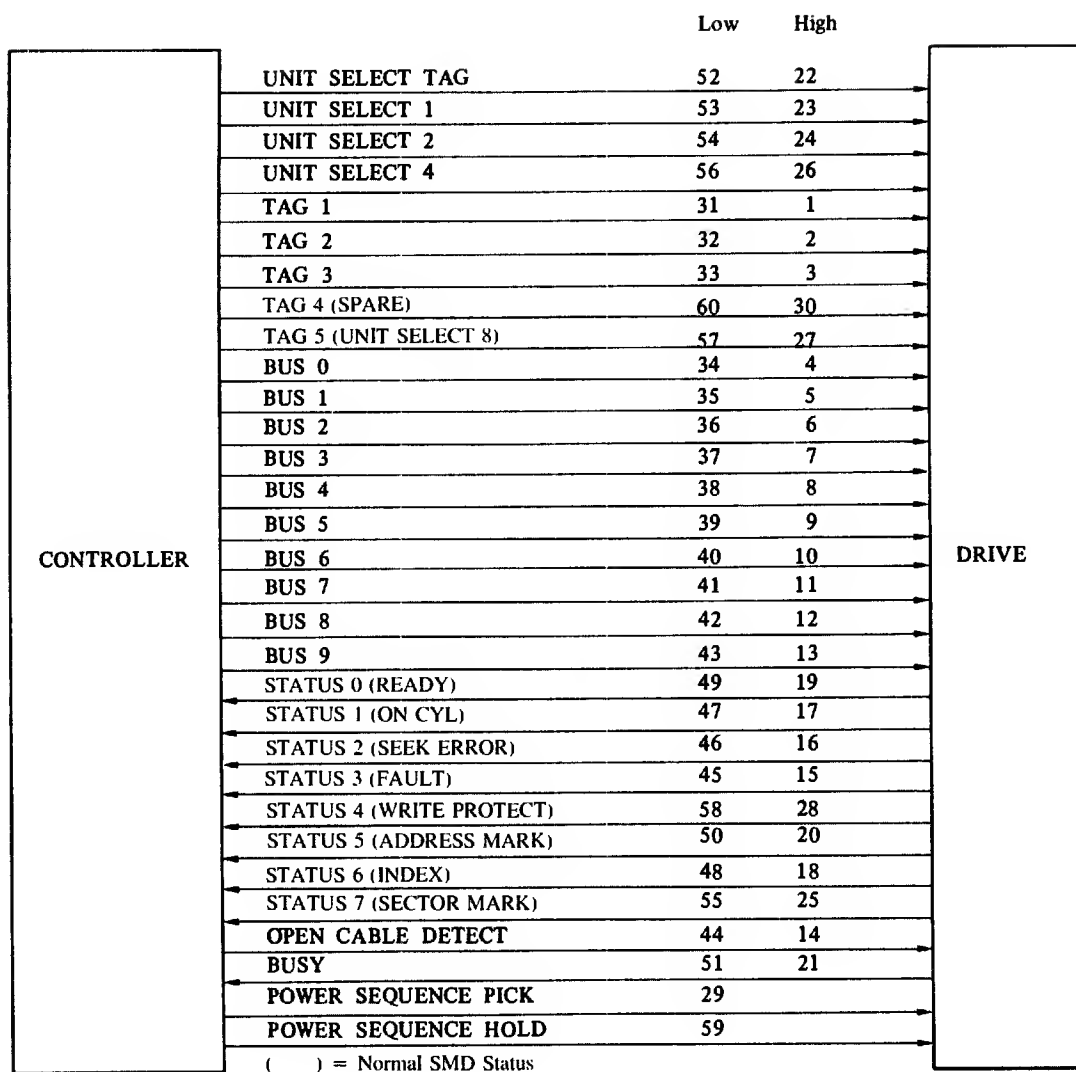


Fig. 7.2-1 A-Cable

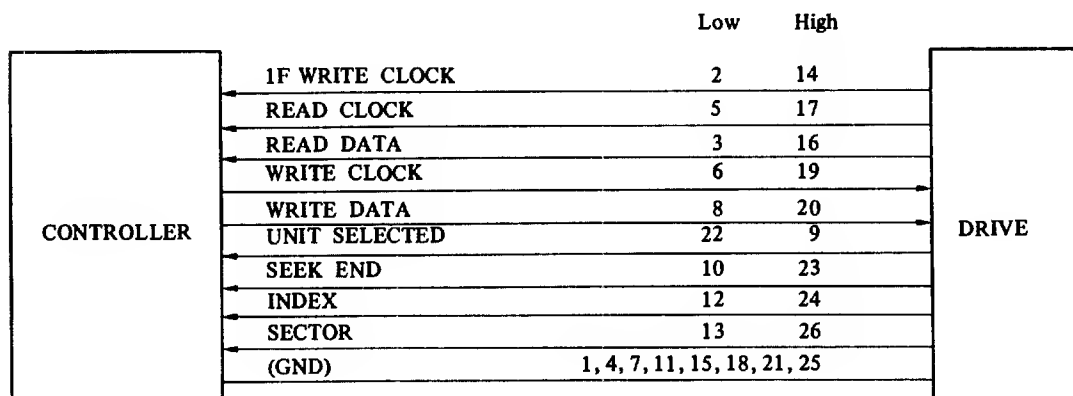


Fig. 7.2-2 B-Cable

### 7.3 A-CABLE INPUT SIGNALS

#### (1) Unit Select Tag

This signal gates Unit Select 1, 2 and 4 to select the drive. Refer to timing of Unit Select (Figure 7.7-1 if dual channel option is not installed, or Figure 7.7-23 if dual channel option is installed). Elaboration of the dual channel select operation follows.

Suppose that the dual channel option is installed and the drive has been reserved by Unit Select command from channel-A, the drive is not selectable from channel-B until a Release command will be issued from channel-A or the internal 500 ms timer times out. However, Priority Select from channel-B can interrupt the reserved status at any time. (Refer to Figure 7.7-23)

On the other hand, if the dual channel option is installed and the drive has been reserved by a Priority Select command from channel-A, channel-B cannot reserve the drive with Unit Select or Priority Select command until a Release command from channel-A is issued. (Refer to Figure 7.7-24)

#### (2) Unit Select 1, 2 and 4

These three signals are binary-coded to select the drive and are validated by the leading edge of Unit Select Tag. The logical number of the drive (0 through 7) is selectable by means of a switch located on the PCB (DQEMU; B16B-8140-0010A#U).

Table 7.3-1 Tag/Bus

| Bus | Tag 1            | Tag 2        | Tag 3              | (With Unit<br>Select Tag) |
|-----|------------------|--------------|--------------------|---------------------------|
|     | Cylinder Address | Head Address | Control Select     |                           |
| 0   | 1                | 1            | Write Gate         | -                         |
| 1   | 2                | 2            | Read Gate          | -                         |
| 2   | 4                | 4            | Servo Offset Plus  | -                         |
| 3   | 8                | 8            | Servo Offset Minus | -                         |
| 4   | 16               | 16           | Fault Clear        | -                         |
| 5   | 32               | -            | AM Enable          | -                         |
| 6   | 64               | -            | RTZ                | -                         |
| 7   | 128              | -            | -                  | -                         |
| 8   | 256              | -            | -                  | -                         |
| 9   | 512              | -            | Release*           | Priority<br>Select*       |

\* Dual Channel only.

### (3) Cylinder Address (Tag 1)

The cylinder address is set by Tag 1 and Bus 0 to 9. Throughout Tag 1, the Bus must be stable. Refer to Figures 7.7-2 and -3.

The drive must be On Cylinder prior to Tag 1. When the Bus content is equal to or more than 896 for the drive with fixed heads, the Fixed Head area is selected. When the Fixed Head area is selected, no physical movement of the heads is performed in the drive.

Fixed Head and Movable Head Addresses are specified as follows. (Storage capacity shown is unformatted). Refer to Figure 7.3-1.

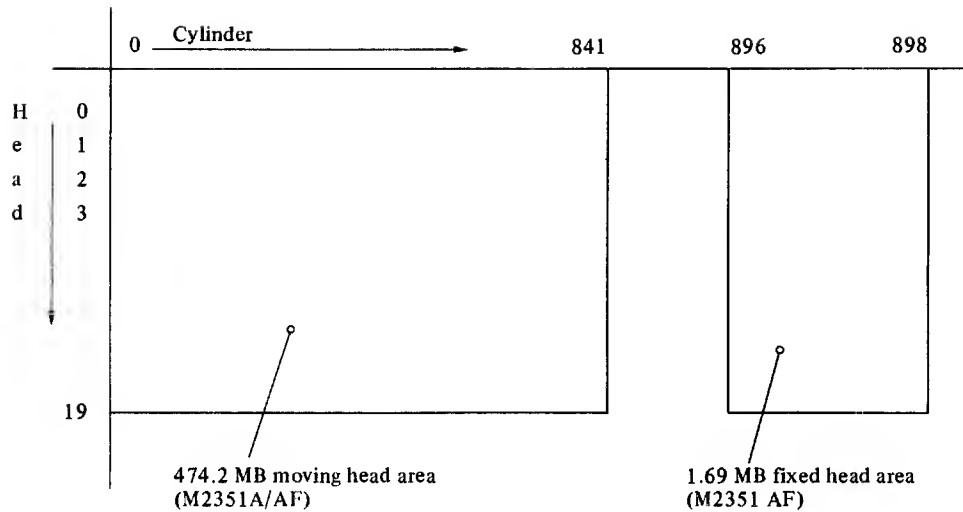


Fig. 7.3-1 Mapping

Detection of Over Cylinder;

Table 7.3-2 shows responses from the drive when illegal cylinder address is issued from the controller.

Table 7.3-2 Responses for Over Cylinder

| <div>CYL.</div> <div>Drive</div> | 842 ~ 895               | 896 ~ 898     | 899 ~ |
|----------------------------------|-------------------------|---------------|-------|
| M2351A                           | Seek End and Seek Error |               |       |
| M2351AF                          | Seek End and Seek Error | (No response) |       |

#### (4) Head Address (Tag 2)

The head address is set by Tag 2 and Bus 0 to 4. Throughout Tag 2, Bus 0 to 4 must be stable. Refer to Figures 7.7-4, -5, -6, -7 and -8.

If the Head Address transferred from the controller is equal to or more than 20, no response is generated in the drive.

#### (5) Control Select (Tag 3)

Bus 0 to 9 gated by Tag 3 have a different meaning in each bit. All signals are defined as control signals.

##### (5-1) Write Gate (Bus 0)

Enables the write operation on the specified track. It is validated under the following conditions;

|                   |       |       |
|-------------------|-------|-------|
| Unit Ready        | ----- | True  |
| On Cylinder       | ----- | True  |
| Seek Error        | ----- | False |
| Fault             | ----- | False |
| Open Cable Detect | ---   | True  |
| File Protected    | ----- | False |
| Servo Offset      | ----- | False |
| Read Gate         | ----- | False |

If Write Gate is turned on in cases other than the above mentioned conditions, Fault occurs and the Write operation is inhibited immediately. See Figures 7.7-4, -7, -20, -21 and -22.

##### (5-2) Read Gate (Bus 1)

Enables the Read operation on the specified track. It is validated under the following conditions;

|                   |       |       |
|-------------------|-------|-------|
| Unit Ready        | ----- | True  |
| On Cylinder       | ----- | True  |
| Seek Error        | ----- | False |
| Fault             | ----- | False |
| Open Cable Detect | ---   | True  |
| Write Gate        | ----- | False |

See the Read Gate timing chart in Figures 7.7-4, -7, -21 and -22.

#### (5-3) Servo Offset Plus (Bus 2)

When this signal is true, the head is offset 100 micro-inches away from nominal On Cylinder position in the outer direction with the responses of Seek End and On Cylinder after 5 ms. Data cannot be written in the offset mode. An attempt to do so will result in the drive setting a fault indication. See Figure 7.7-9.

When Servo Offset Plus and Minus are sent simultaneously, Servo Offset Plus will be effective.

#### (5-4) Servo Offset Minus (Bus 3)

When this signal is true, the head is offset 100 micro-inches away from nominal On Cylinder position in the inner direction with the responses of Seek End and On Cylinder after 5 ms. Data cannot be written while in the offset mode. An attempt to do so will result in the drive setting a fault indication. See Figure 7.7-9.

#### (5-5) Fault Clear (Bus 4)

This signal clears the fault status i.e., Write/Read Check Status, however, if the cause of the Fault condition still exists, the status will not be cleared. See Figure 7.7-10.

#### (5-6) AM Enable (Bus 5)

AM Enable, in conjunction with Write Gate or Read Gate, is used in a Variable Sector Format. When AM Enable is true while Write Gate is true, an AM of three bytes (DC erase) is written on the track.

Refer to Figure 7.7-11.

When AM Enable is true while Read Gate is true, the read circuit searches an AM of three bytes (DC erased). When the AM is found, the drive will issue Address Mark Found to the controller.

See Figure 7.7-12.

(5-7) RTZ (Bus 6)

Wherever the movable heads are located, they return to cylinder zero and head zero when the RTZ signal is received. Also, the RTZ signal is functional in the fixed head area and resets Fixed Head Select latch. This signal clears the Seek Error.

Refer to Figure 7.7-13.

(5-8) Release (Bus 9); Dual Channel only

After the drive is reserved by Unit Select or Priority Select, Release command becomes valid at Tag 3 and Bus 9. Enabling this signal will release the reserved status in the drive, making alternate channel access possible after selection by the other channel. (Refer to Figures 7.7-23 and -24.)

If the drive has been reserved by Unit Select and the Release Timer Switch on the optional dual channel PCB (DQFMU; B16B-8150-0010A#U) is set to RLTM side, the drive will automatically release the reserved condition approximately 500 ms after the Unit Select command is issued.

(6) Priority Select (Bus 9 with Unit Select Tag and Unit Select 1, 2, 4)

By sending Priority Select (Bus 9) along with Unit Select Tag, Unit Select 1, 2, 4, a controller can select the drive even if it has been selected or reserved by the other channel, except when its own channel is disabled by the Disable switch or the drive is priority selected by the other channel.

With this command, the drive is set in the unconditionally reserved state with respect to that channel. Once it is unconditionally reserved, the control becomes exclusive, i.e., the other channel cannot access the drive until the drive is released from the controller which has reserved the drive. If the drive is unconditionally reserved, all the signals including Unit Selected, and Busy signals are inhibited with respect to the other channel. (Refer to Figure 7.7-24).

(7) Open Cable Detect (Channel Ready)

This signal is used to prevent damage of data caused by interface disturbances when the power to the controller is lost. Therefore, this signal must be stable when the controller is available, and must be disabled before logic levels decay on the interface when a power failure occurs in the controller.

Refer to Figure 7.7-14.

#### (8) Tag 4 and 5

Unit Status, Sector Status, Write/Read Check Status and Access Status can be sensed throughout Status 0- 7 lines with a combination of those two coded signals. Status 0 to 5 for Unit Status are always displayed by 5 LEDs and Status 0 to 7 for DE Sequence State, Write/Read Check State and Access State are also displayed by 7-segment LEDs on the PCB (HGAMU; B16B-7830-0010A#U) for maintenance aid.

See Table 7.4-1 for information about these Tags.

Note that Unit Status can be made available on the interface by shorting a circuit on the Logic PCB (C16B-5123-0980#U) with a shorting plug.

See Figure 7.7-15 for time specifications.

#### (9) Power Sequence Pick/Hold

Power Sequence is required when the Remote/Local switch on the power supply unit is set to Remote. In this mode, when the controller sets the Pick and Hold lines to ground, the first drive's spindle starts rotating if the start switch has been pressed. Approximately five seconds later the Pick signal is transferred to the next drive, and this is repeated until all drives are sequenced up. When both signals go false, the spindle stops rotating. If the mode switch on the power supply unit is set to Local, each Start Switch must be pressed manually to start the spindle rotating. Refer to Figure 7.7-16.



## 7.4 A-CABLE OUTPUT SIGNALS

### (1) Status 0 to 7

The Status 0 to 7 lines indicate status information determined by combinations of Tag 4 and Tag 5 signals. Information available is specified in Table 7.4-1.

Table 7.4-1 Status

| Tag 4  | False              | True          | False                       | True                  |
|--------|--------------------|---------------|-----------------------------|-----------------------|
| Tag 5  | False              | False         | True                        | True                  |
| Status | Unit Status        | Sector Status | Write/Read Check Status     | Access Status         |
| 0      | Unit Ready         | Sector 1      | Index Check                 | DE Sequence Check     |
| 1      | On Cylinder        | Sector 2      | Control Check               | Access Time-Out Check |
| 2      | Seek Error         | Sector 4      | Multi Head Check            | Over Shoot Check      |
| 3      | Fault              | Sector 8      | Head Short Check            | Rezero Mode Latch     |
| 4      | Write Protected    | Sector 16     | Write Current on Read Check | Servo Latch           |
| 5      | Address Mark Found | Sector 32     | Write Transition Check      | Linear Mode Latch     |
| 6      | Index              | Sector 64     | Delta I Write Check         | Control Latch         |
| 7      | Sector             | Sector 128    | Servo Off-Track             | Wait Latch            |

### (2) Unit Status

When both Tag 4 and 5 are False, Status 0 ~ 7 indicate the basic information required for the Seek, Read and Write operations.

#### (2-1) Unit Ready (Status 0)

When this signal is true and the drive is selected, this signal indicates that the drive has reached the rated speed. Note that when the drive is in fault condition, Unit Ready may or may not be issued depends on the position of a jumper plug as described in Table 3.3-1.

#### (2-2) On Cylinder (Status 1)

Indicates that the heads are located on the specified track. This signal goes false for approximately 5 ms at the beginning and at the end of the offset operation. For a zero Track Seek, On Cylinder will go false for max. 10 us.

#### (2-3) Seek Error (Status 2)

Indicates that a Seek Error has occurred. In this case, On Cylinder does not go true. The Seek Error is cleared when an RTZ (Tag 3 and Bus 6) is received or by pushing the Fault Clear Switch on the operator panel or maintenance-aid MRTZ Switch on the PCB (HGAMU; B16B-7830-0010A#U). The Seek Error status is defined as follows;

1. Seek or RTZ operation is not complete within the specified time.
2. Heads travel to a position outside the recording area.
3. An illegal cylinder address is issued to the drive.
4. Head overshoots to an unspecified cylinder address.
5. Seek command is received by the drive during the not On Cylinder status, when the heads are in motion, or during a Write/Read operation.

#### (2-4) Fault (Status 3)

Indicates that a fault condition for Write/Read operation exists in the drive. Fault conditions are described in the Write/Read Check status in detail.

If one of the Fault conditions occurs, writing is immediately inhibited and the Fault signal is issued to the controller.

The Fault status can be cleared by one of the following operations;

1. Fault Clear on Tag 3 and Bus 4
2. Fault Clear switch on the operator panel
3. Pushing on the maintenance-aid MRTZ Switch on the PCB  
(HGAMU; B16B-7830-0010A#U)
4. Switching off the power to the drive
5. Stopping rotation of the spindle motor

Fault Status turns on the check lamp on the operator panel as well as Maintenance Aid LED on the PCB.

#### (2-5) Write Protected (Status 4)

Indicates that the drive is in the write-protected mode. The write-protect function is enabled by the File Protect Switch on the operator panel, and becomes active while the drive is not selected. If the drive is selected and the write-protect-function is desired, the drive must be momentarily deselected.

#### (2-6) Address Mark Found (Status 5)

Address Mark Found is an 8-Byte pulse which is sent to the controller at least 2 Bytes after the recognition of a 3-Byte DC-erased area.

#### (2-7) Index (Status 6)

Index mark is derived from the servo information. It occurs once per revolution and is used for reference in Write/Read operation.

Refer to Figure 7.7-17 for the timing of Index and Sector.

#### (2-8) Sector (Status 7)

The Sector mark is also derived from the servo information. The number of sectors per revolution is selectable by 15 jumper plugs and is determined by counting Byte Clock. The jumper pins are located on the Logic PCB (C16B-5123-0980#U). Each pin represents a binary number minus 1 of Byte Clock to be counted in each sector.

#### (3) Sector Status (Status 0 ~ 7)

Indicates the current sector address from 1 to 255 in the drive. Refer to Figure 7.7-17 for timing of Sector Address.

#### (4) Write/Read Check Status

Indicates the fault status while in the Write or Read operation. When one of these conditions occurs in the drive, the Fault signal in the Unit Status is issued as a summary to the controller. It can be cleared by a Fault Clear Signal from the controller.

##### (4-1) Index Check (Status 0)

Indicates that the Index signal is not detected where it should be or was detected where it should not have been while performing Write/Read operations.

##### (4-2) Control Check (Status 1)

The following fault conditions cause Control Check.

1. Write and Read Gate are issued at the same time.
2. Write operation during offset mode.
3. Write Gate is issued in the write protect mode.

##### (4-3) Multi-Head Check (Status 2)

Indicates that two or more head ICs are selected simultaneously. (One DE has five head ICs and four heads are connected to one head IC.)

##### (4-4) Head Short Check (Status 3)

Indicates that abnormal current was sensed in the Write Select line during write operation.

##### (4-5) Write Current on Read Check (Status 4)

Indicates that write current was sensed during a read operation.

##### (4-6) Write Transition Check (Status 5)

Indicates that write current has not been switched for writing data. The detection is continued from byte-8 after Write Gate is true until the end of the Write operation.

(4-7) Delta I Write Check (Status 6)

Indicates that an abnormal write current was sensed in the inner head, outer head or fixed head.

(4-8) Servo Off-Track (Status 7)

Indicates the following fault conditions.

1. The head is  $\pm 100$  micro inches off the desired track during the Write/Read operation.
2. Write/Read Gate is received by the drive during not On Cylinder status, heads in motion or seek error.

(5) Access Status

Indicates access status of the head in Seek and RTZ operation. It also indicates start and stop sequence of the spindle motor.

(5-1) DE Sequence Check (Status 0)

Indicates that an abnormal start/stop sequence of the DE occurred in the drive. Latch 4, Latch 2, and Latch 1 of DE SEQ represent the various DE sequence status as shown in the following table:

Table 7.4-2 Contents of DE Sequence Latches

| State No. | Latch 4 | Latch 2 | Latch 1 | Status                                                                                       |
|-----------|---------|---------|---------|----------------------------------------------------------------------------------------------|
| 0         | 0       | 0       | 0       | Wait status                                                                                  |
| 1         | 0       | 0       | 1       | The START/STOP switch on the operator panel is set to START.                                 |
| 3         | 0       | 1       | 1       | The spindle motor starts rotating.                                                           |
| 2         | 0       | 1       | 0       | Sequence Rezero starts approximately 40 seconds after State 3.                               |
| 6         | 1       | 1       | 0       | Sequence Rezero is completed and seek operation is possible.                                 |
| 7         | 1       | 1       | 1       | DE Stop Sequence State results and the head begins to return to the home position. (Go Home) |
| 5         | 1       | 0       | 1       | Go Home operation is completed and the spindle motor stops rotating.                         |
| 4         | 1       | 0       | 0       | Approximately 40 seconds have passed since State 5. (Returns to State 0.)                    |

One of the following errors occurred as DE Sequence State advanced:

1. Initial State Good (Motor At Speed and Hall Alarm are not present) does not result in State 1.
2. Run State Good (not Hall Alarm and Motor At Speed are sent out) cannot be obtained for approximately 40 seconds in State 3.
3. Run State Good goes off during State 6.

It cannot be cleared by the Fault Clear Switch on the operator panel or Fault Clear signal on the interface but only by stopping rotation of the spindle.

#### (5-2) Access Time-Out Check (Status 1)

During an RTZ or Seek operation, On Cylinder failed to appear within 250 ms  $\pm 30\%$  after Access Start. It can be cleared by RTZ operation.

(5-3) Over-Shoot Check (Status 2)

Indicates the heads go past the desired track during Seek or RTZ operation or go into the Guard Band during a Seek operation.

It also indicates that the heads are moving at abnormal speed during RTZ operation.

Over-Shoot Check can be cleared by RTZ operation.

(5-4) Rezero Mode Latch (Status 3)

Servo Latch (Status 4)

Linear Mode Latch (Status 5)

Control Latch (Status 6)

Wait Latch (Status 7)

These five latches observe the sequence of seek and RTZ operations. Whenever an error occurs during Seek or RTZ, the content of these latches are frozen at that time, so that they are beneficial for error analysis. They can be cleared by RTZ operation. The relationship between access state and the contents of latches is shown in Table 7.4-3.

Table 7.4-3 Access States

| Rezero Mode Latch | Servo Latch | Linear Mode Latch | Control Latch | Wait Latch | State            | Mode  |
|-------------------|-------------|-------------------|---------------|------------|------------------|-------|
| 0                 | 0           | 0                 | 0             | 1          | Wait State       | Reset |
| 0                 | 0           | 0                 | 0             | 0          | Start RTZ        | RTZ   |
| 1                 | 0           | 0                 | 0             | 0          | Move In          |       |
| 1                 | 0           | 0                 | 1             | 0          | Turn Around      |       |
| 1                 | 0           | 1                 | 1             | 0          | Move Out         |       |
| 0                 | 0           | 1                 | 1             | 0          | RTZ Linear Mode  |       |
| 0                 | 1           | 1                 | 1             | 0          | On Track         |       |
| 0                 | 1           | 0                 | 1             | 0          | Accelerate       | Seek  |
| 0                 | 1           | 0                 | 0             | 0          | Decelerate       |       |
| 0                 | 1           | 1                 | 0             | 0          | Seek Linear Mode |       |
| 0                 | 1           | 1                 | 1             | 0          | On Track         |       |

(6) Busy (Dual Channel only)

If the drive has been already reserved and/or selected, a Busy signal will be issued together with Unit Selected to the other channel attempting the select. Busy signal will remain true until Unit Select Tag is dropped or the Busy condition in the drive is released.

It is necessary to gate Busy signal by Unit Selected signal at the controller.



## 7.5 B-CABLE INPUT SIGNALS

### (1) Write Data

Carries NRZ data which is to be written on the disk surface and must be synchronized with Write Clock. Refer to Figure 7.7-18.

### (2) Write Clock

Write Clock is a return signal of the 1F Write Clock issued from the drive as shown in Figure 7.5-1, and must be synchronized with the NRZ Write Data. Refer to Figure 7.7-18.

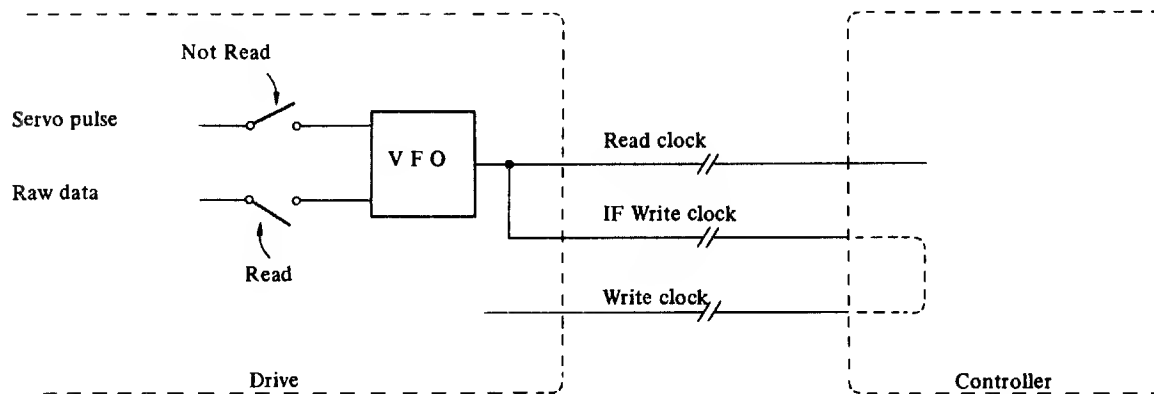


Fig. 7.5-1 Generation of Write/Read Clock

## 7.6 B-CABLE OUTPUT SIGNALS

### (1) 1F Write Clock

Used by the controller to synchronize Write Data and Write Clock. It is synchronized to the Servo Pulse while in the Write operation and to the Raw Data during in a Read operation. Refer to item (1) of Chapter 7.5 and Figure 7.7-18.

### (2) Read Data

Transmits the recovered data in the form of NRZ data synchronized with the Read Clock. Refer to Figure 7.7-19.

### (3) Read Clock

Transmits Read Clock which defines the beginning of a bit cell. The Read Data is synchronized with the Read Clock. Refer to Figure 7.7-19.

### (4) Unit Selected

When three Unit Select lines match with the logical address of the drive, and the leading edge of Unit Select Tag is received, the Unit Selected goes true and is issued to the controller. This signal activates all signals in the A-Cable. Refer to Figure 7.7-1.

### (5) Seek End

In a combination with On Cylinder or Seek Error, Seek End goes true after a Seek or RTZ, indicating that a Seek or RTZ operation has terminated. Seek End goes false for 5 ms at the beginning and end of an Offset operation in default mode. In the other mode, Seek End never goes false at resetting offset as described in Table 3.3-1.

For a Zero Track Seek, it will go false for max. 10  $\mu$ s. Note that Seek End and On Cylinder do not change when a fixed head is selected. Refer to Figures 7.6-2, -3, -6, -9 and -13.

In case of dual channel sub-system, Seek End is always true to the other channel (unselected channel). Suppose that channel-A attempts to select the drive which has already been selected by channel-B. When channel-B releases Selected and Reserve Condition, Seek End goes false for approximately 30  $\mu$ s for channel-A which has been waiting.

(6) Index

Same as Index signal in the A-Cable which is described in item (2-7) of Chapter 7.4. This signal is available with or without the dual channel feature.

(7) Sector

Same as Sector signal in the A-Cable which is described in item (2-8) of Chapter 7.4. This signal is available with or without the dual channel feature.

## 7.7 TIME SPECIFICATIONS

Timings are specified at the connector position of the drive. It is necessary for signal timings to consider both the delay time of the interface cable and the circuit of the controller.

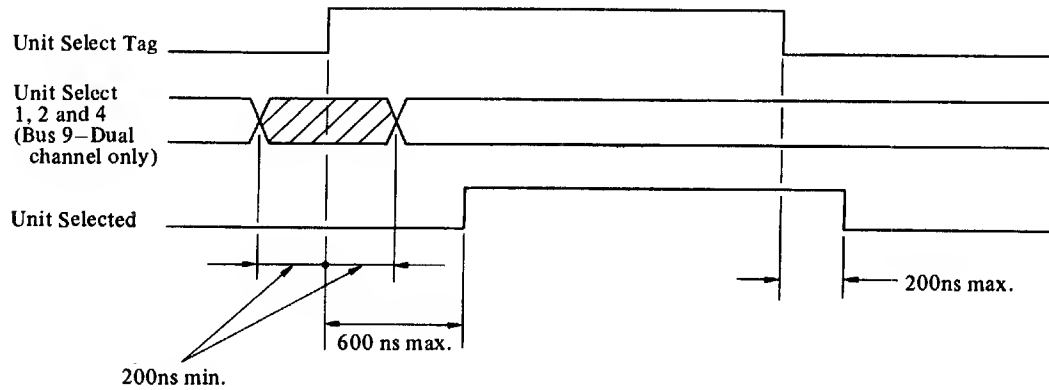
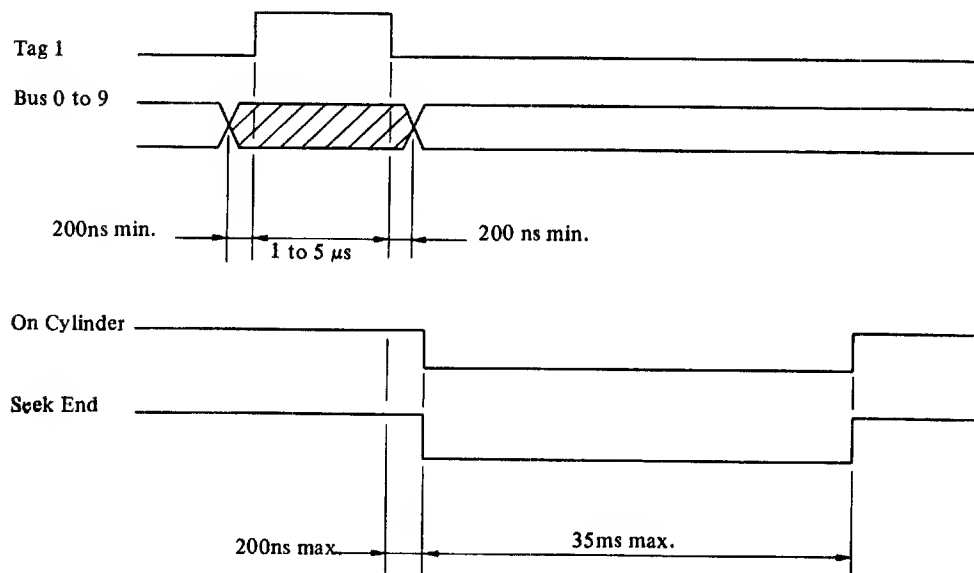


Fig. 7.7-1 Unit Select Timing



Note; The cylinder address must be less than 841 to select a movable head.

Fig. 7.7-2 Seek Timing

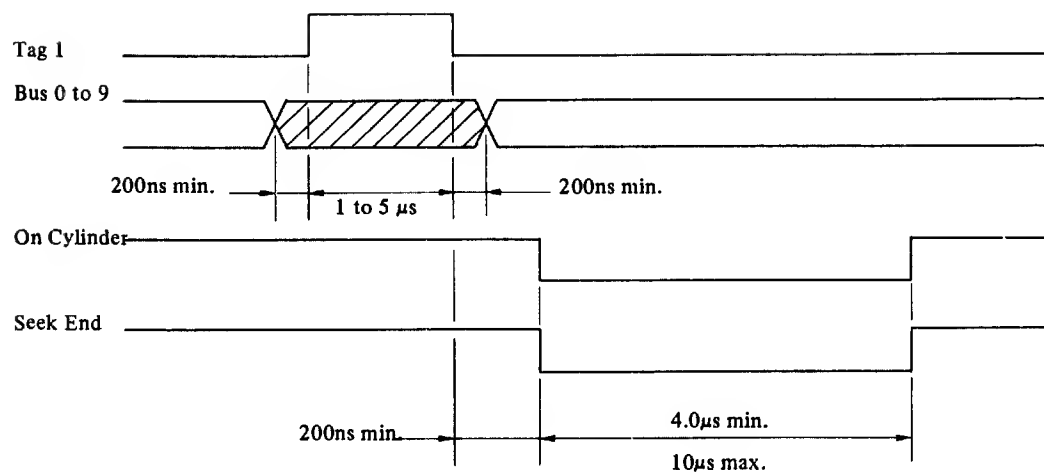


Fig. 7.7-3 Zero Track Seek Timing

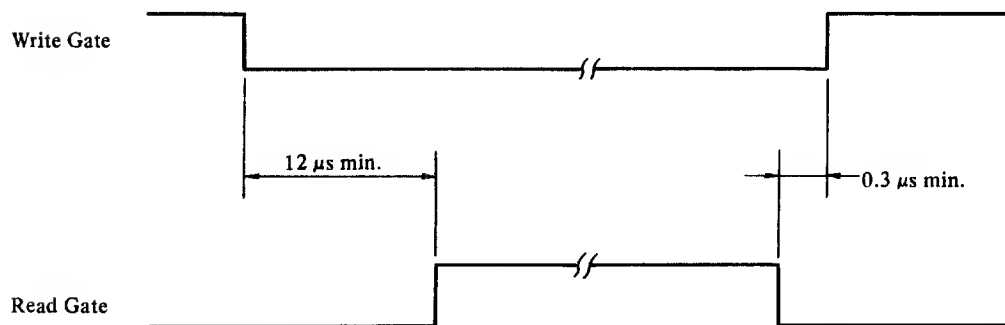
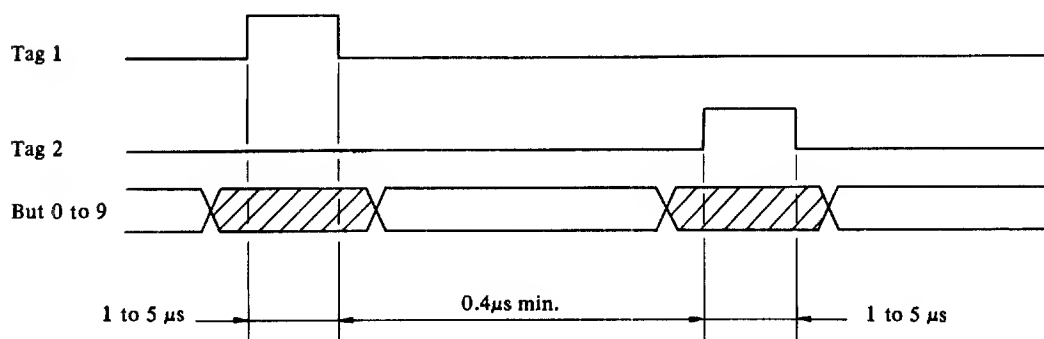
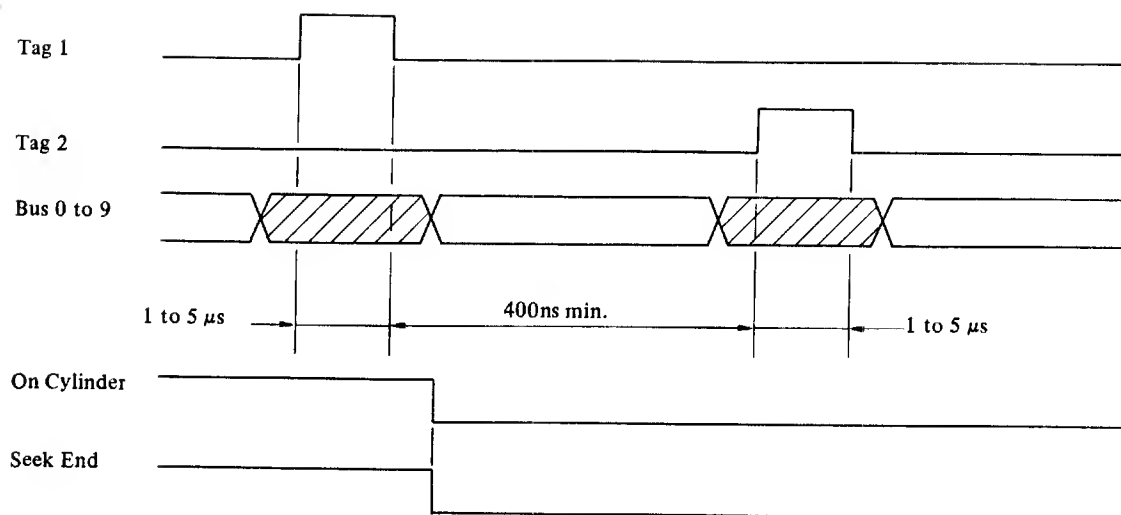


Fig. 7.7-4 Read after Write and Write after Read Timing



Note; When the cylinder address is more than or equal to 896, the cylinder address is defined as a fixed head area and the subsequent Tag 2 is defined as fixed head.

Fig. 7.7-5 Addressing for Fixed Head



Note; Tag 2 can be set during seek operation.

Fig. 7.7-6 Addressing for Movable Head

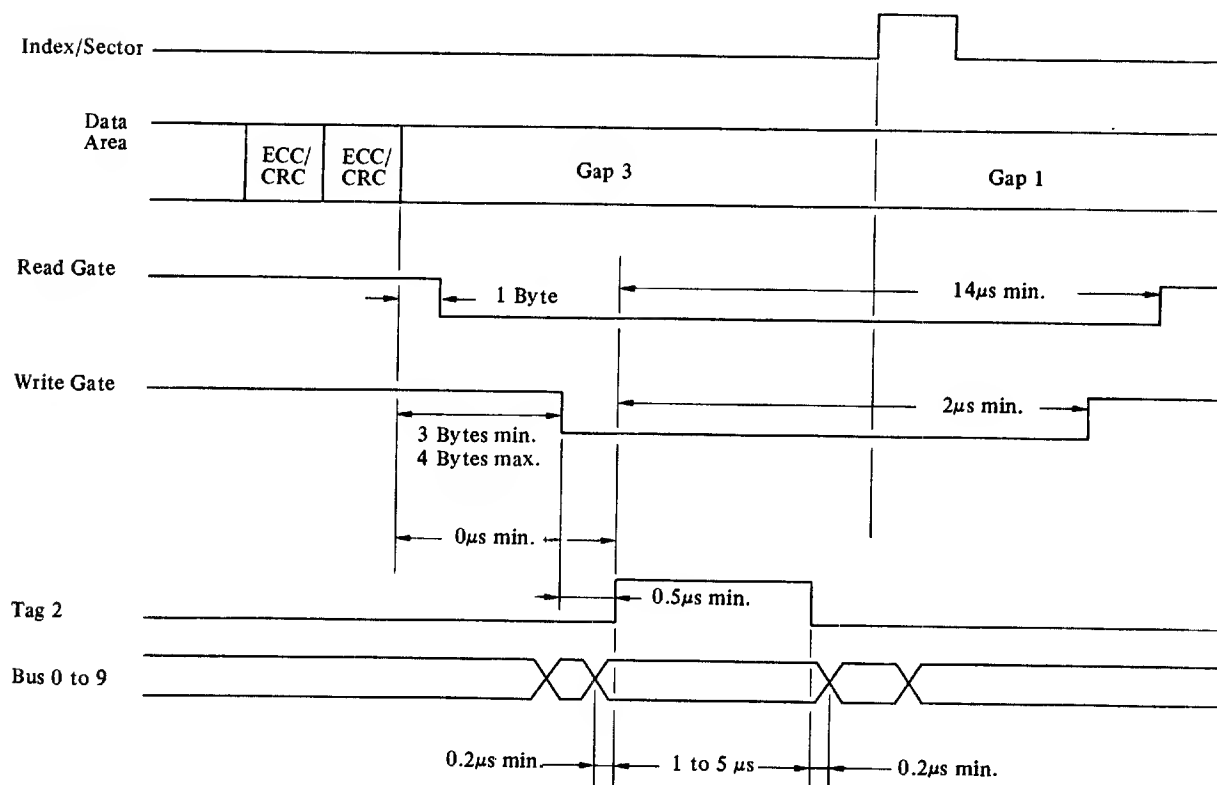


Figure 7.7-7 Head Address Change at the Last Gap

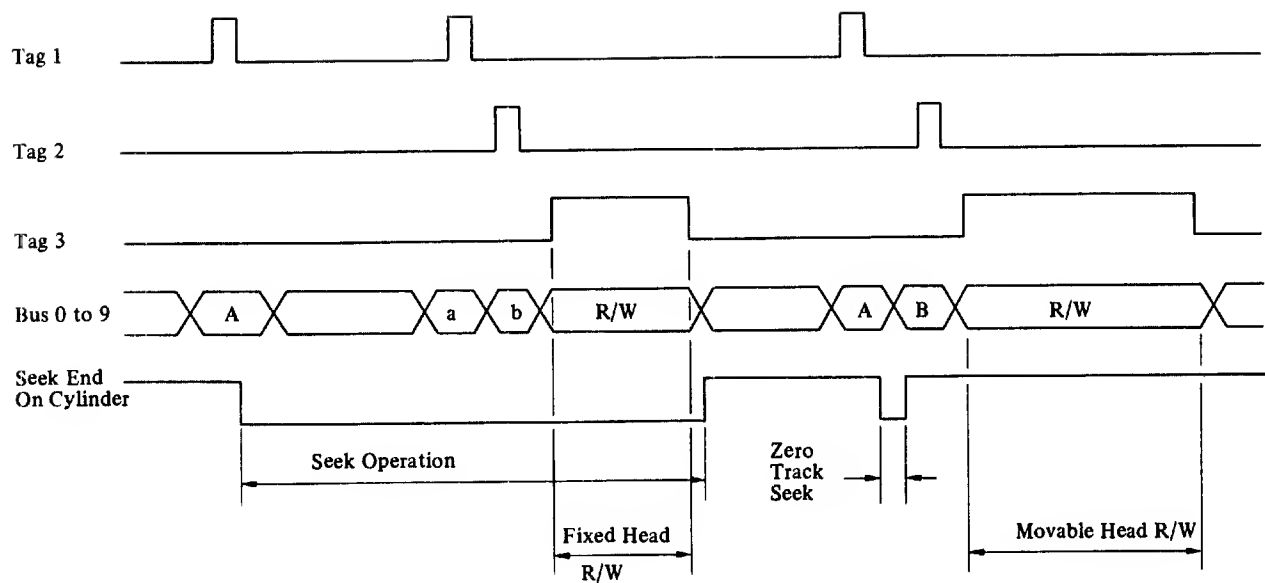
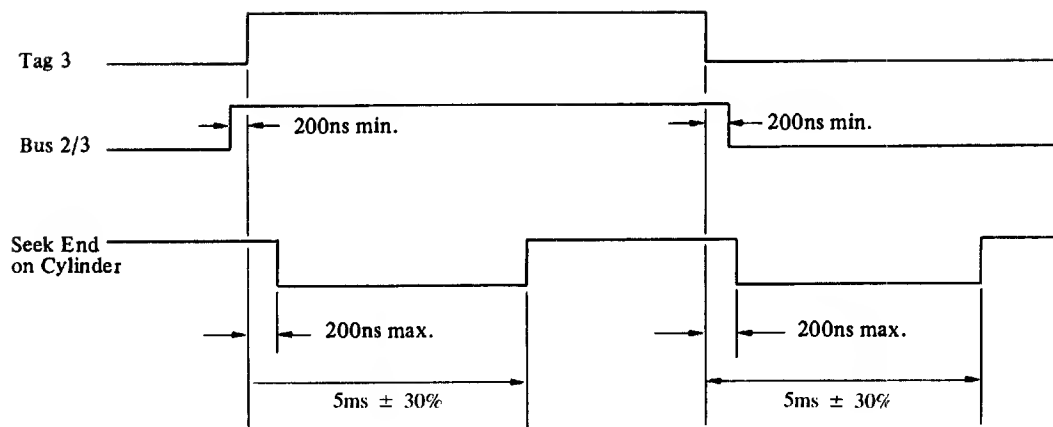


Fig. 7.7-8 Fixed Head Addressing During Seek

The normal sequence of this operation would be in the following order;

- (1) The controller issues Tag 1 (Cylinder Select) with the desired cylinder address (A) of the moving head. On Cylinder and Seek End will go false.
- (2) The controller accesses the desired fixed head area with the appropriate cylinder (896-898) (a) and head (b) select signals.
- (3) The controller can read or write on the fixed head area while the movable heads are in motion. Reading or writing in the fixed head area during the absence of On Cylinder and Seek End will not cause a Fault.
- (4) At the completion of the seek on the movable heads, On Cylinder and Seek End will go true.
- (5) After the write or read operation in the fixed head area, the controller must readdress the movable head by sending the appropriate cylinder select (A) (Zero Track Seek) and head select (B) signals. The cylinder select Tag 1 resets the fixed head mode.



Note that Seek End does not go false at offset-reset operation depending on the position of a jumper plug as described in Table 3.3-1.

Fig. 7.7-9 Offset Timing

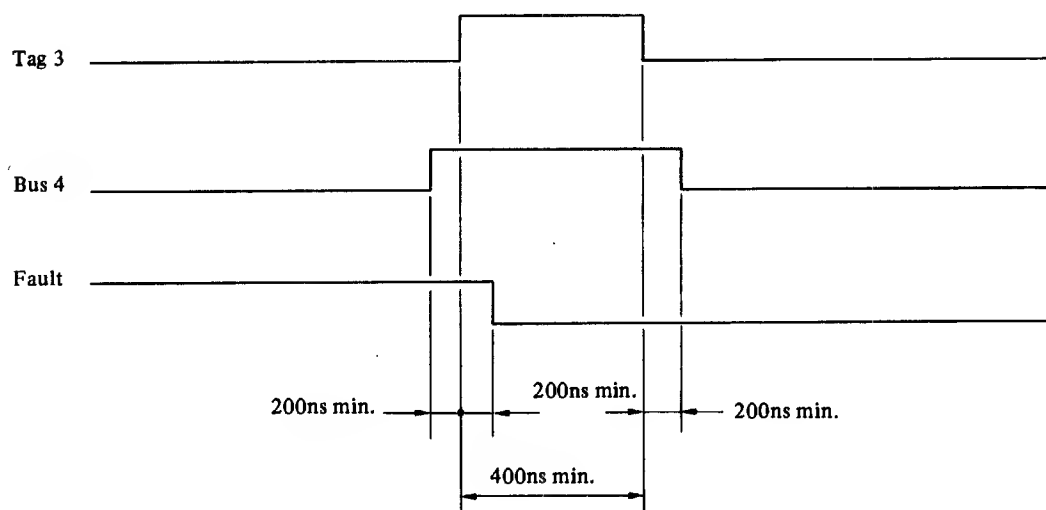


Fig. 7.7-10 Fault Clear Timing



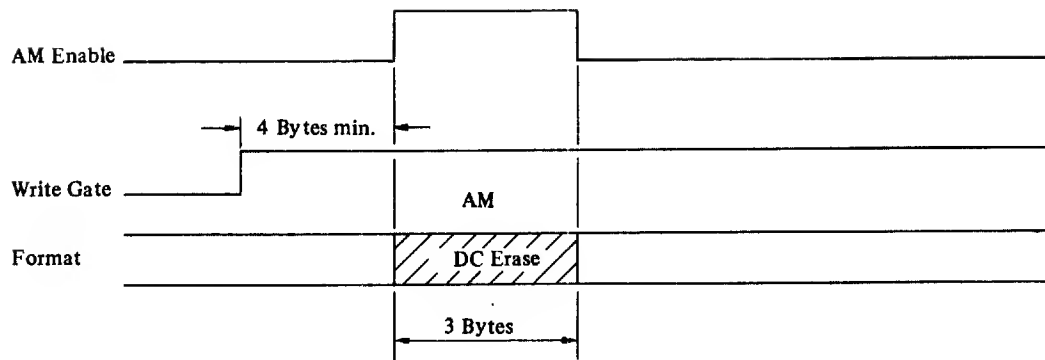


Fig. 7.7-11 AM Write

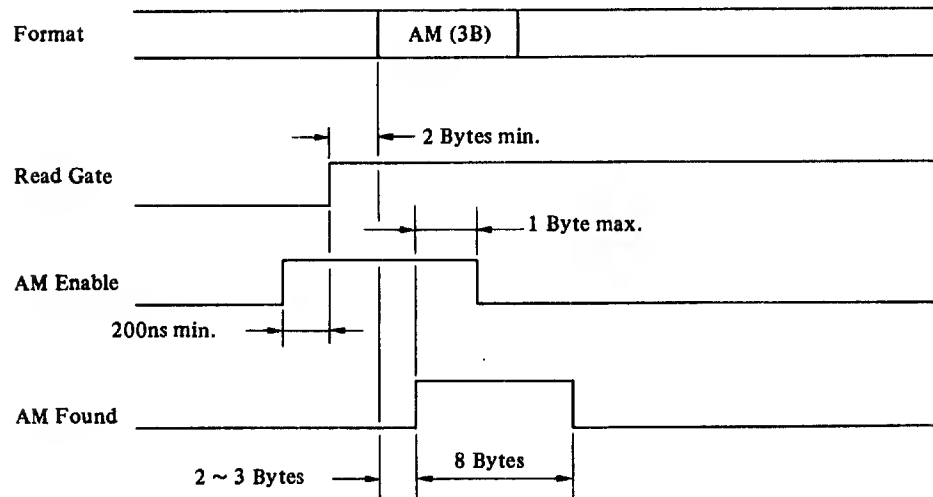
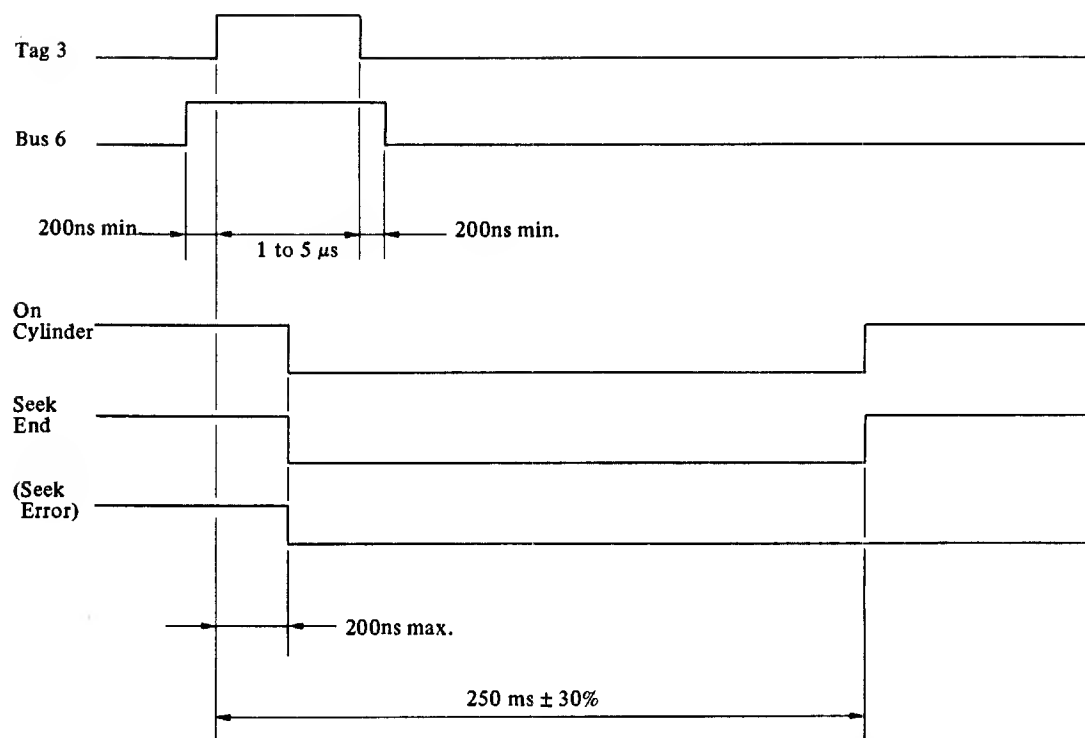
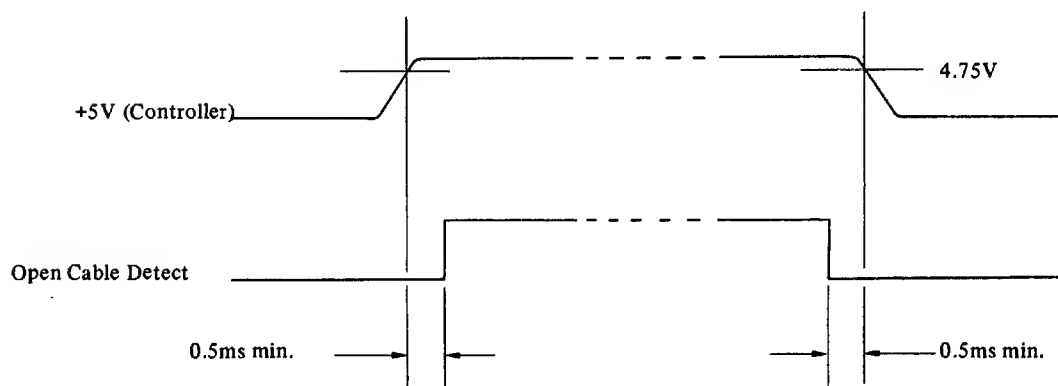


Fig. 7.7-12 AM Detection



Note; On Cylinder is not always set if Seek Error occurs.

Fig. 7.7-13 RTZ Timing



Note; Two Drivers of SN75110 would be required in parallel without termination to increase the drive current in the interface cable.

Fig. 7.7-14 Open Cable Detect Timing

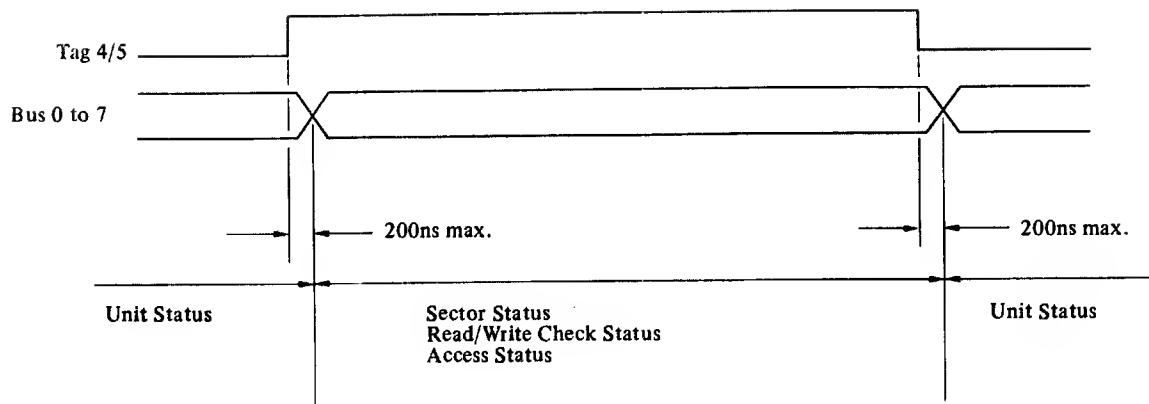


Fig. 7.7-15 Tag 4/5 Timing

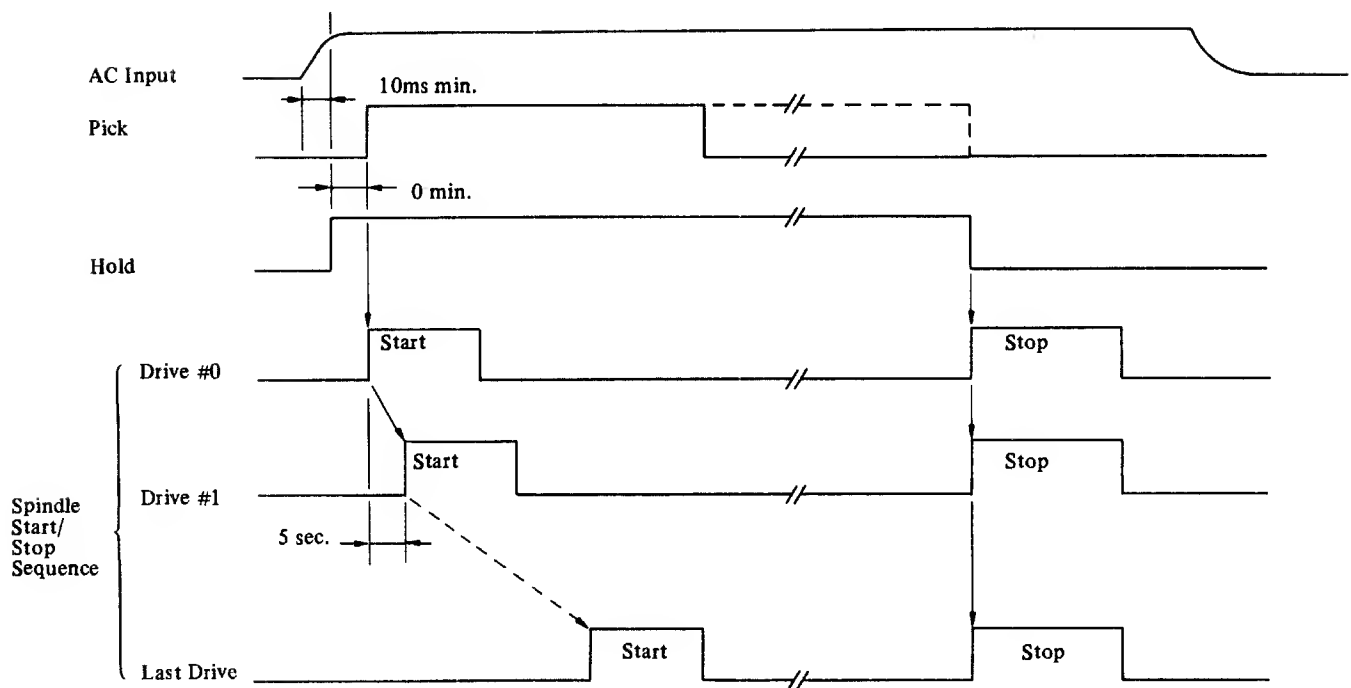


Fig. 7.7-16 Power Sequence Pick/Hold Timing

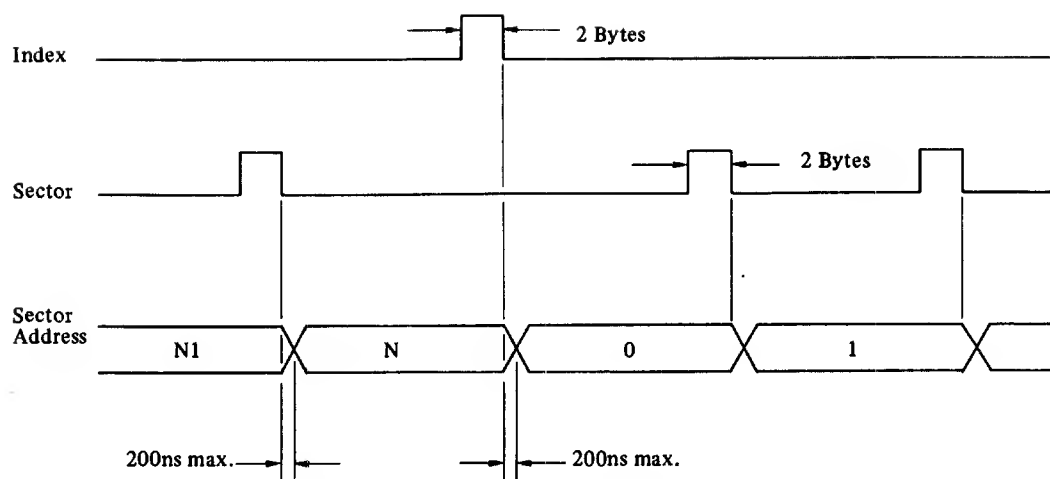
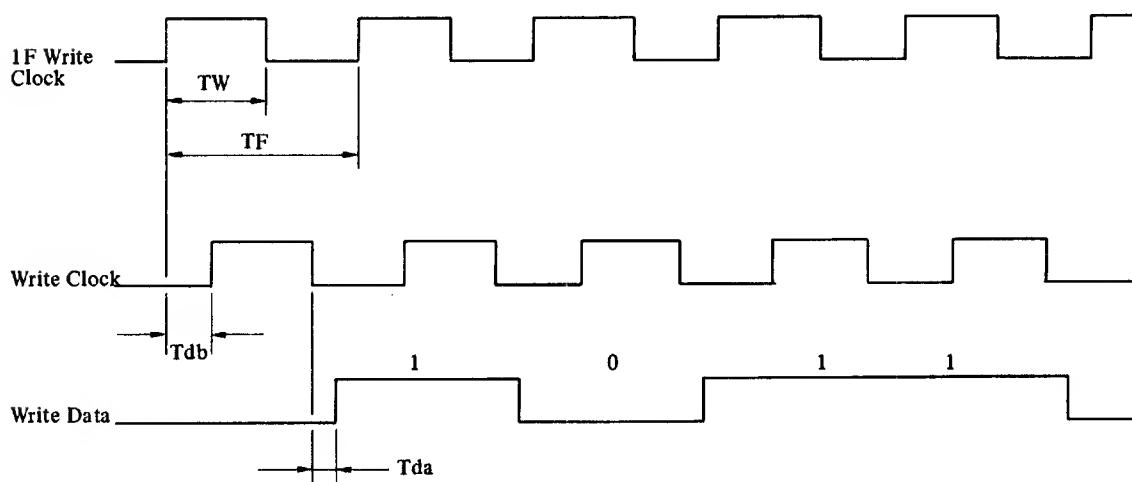


Fig. 7.7-17 Index and Sector Timing



$$TW = TF/2 = 33.62 \pm 2 \text{ ns}$$

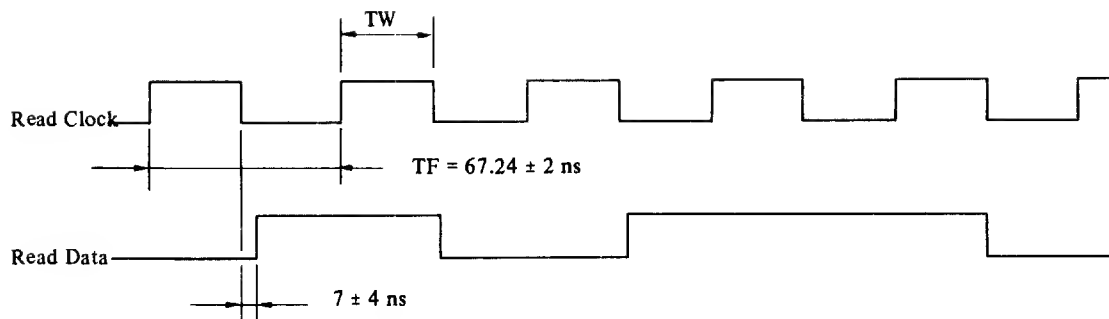
$$TF = 67.24 \pm 2 \text{ ns}$$

$$Tdb = \text{Continuous delay within 4 bits}$$

$$Tda = 0 \pm 15 \text{ ns}$$

- Note; (1) Write Data and Write Clock timing shall be specified at the output connector of the controller.
- (2) The tolerance of TF includes the rotational speed tolerance and the jitter of servo signal.
- (3) NRZ Write Data issued from the controller is put in to the MFM-modulator and then written on the disk surface with write-compensation.

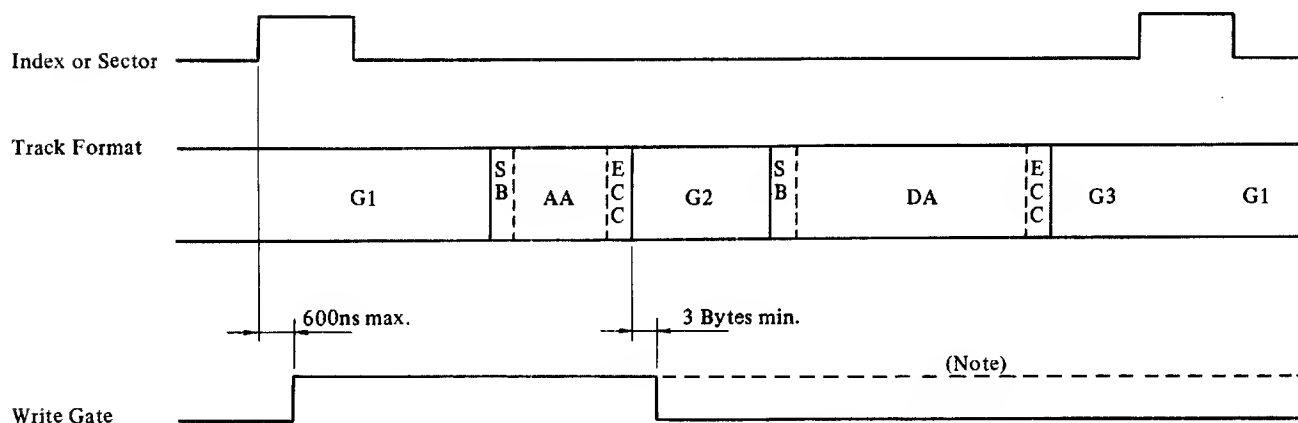
Fig. 7.7-18 Write Clock and Write Data Timing



$$TW = TF/2 = 33.62 \pm 2 \text{ ns}$$

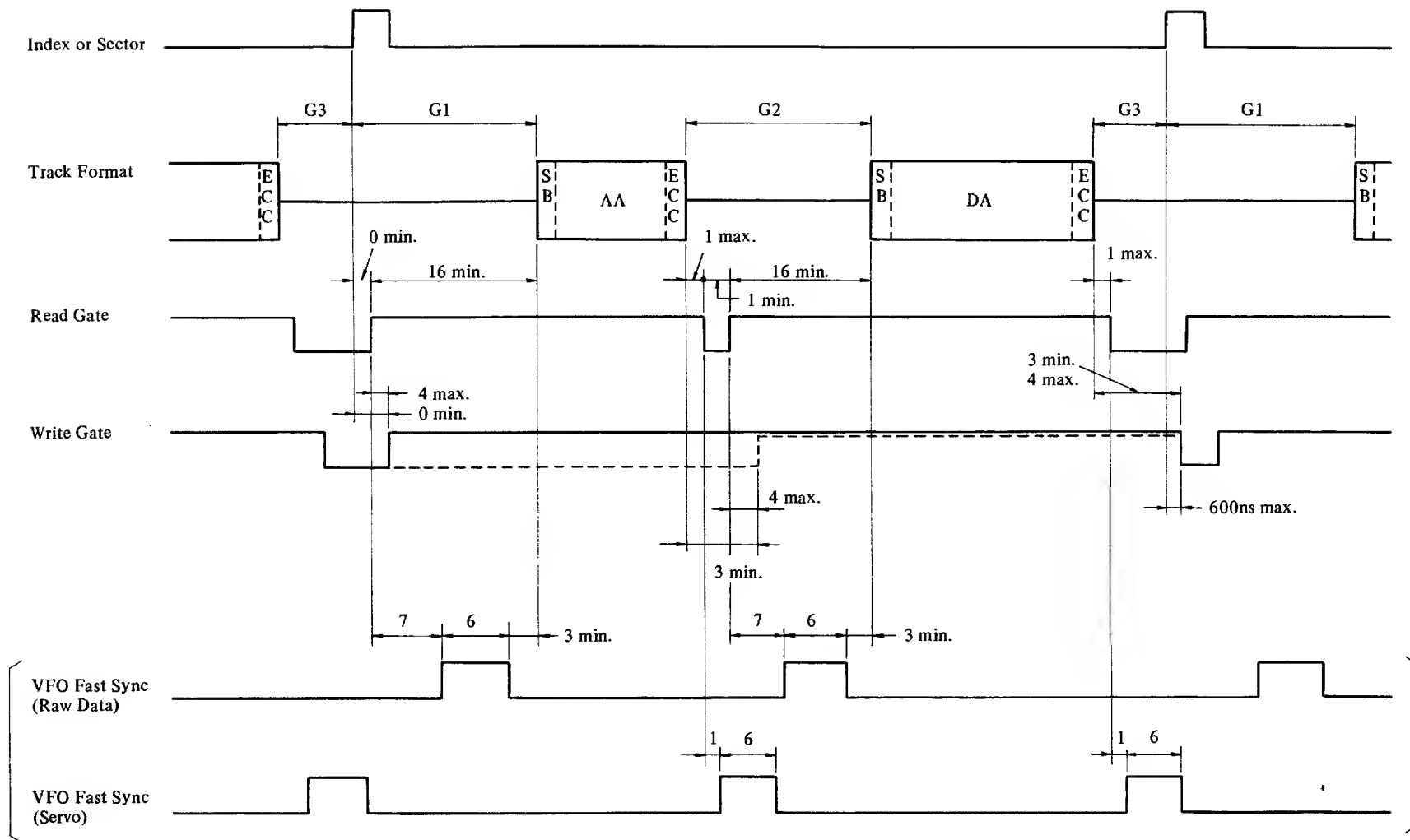
- Note; (1) Read Clock and Read Data timing shall be specified at the output connector of the drive.
- (2) Read Data signal should be clocked at the positive-going edge of Read Clock in the controller.

Fig. 7.7-19 Read Clock and Read Data Timing



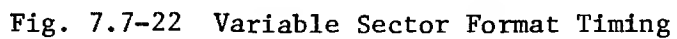
Note: Write Gate may be at high level.

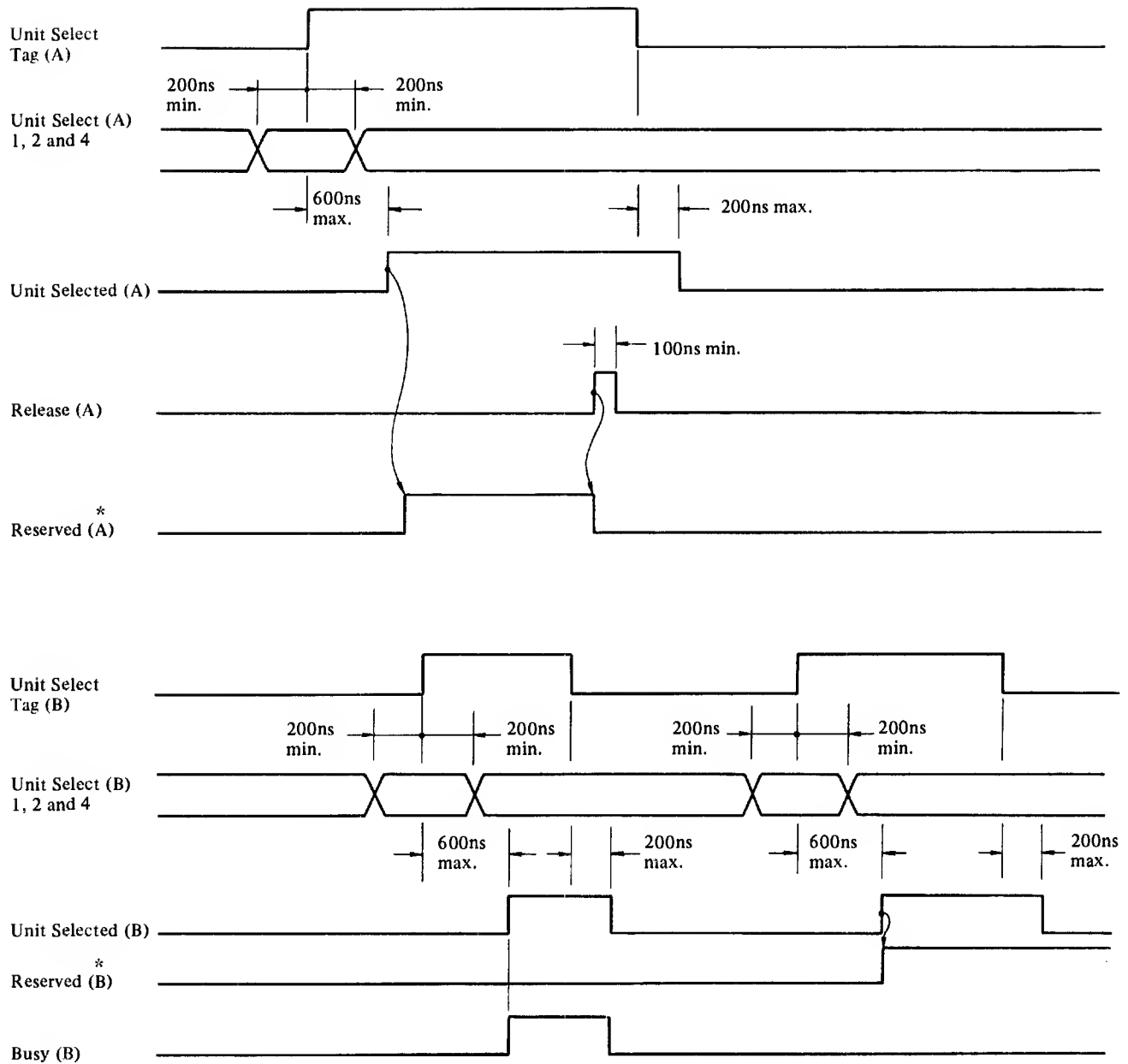
Fig. 7.7-20 Format Write Timing



- \* Unit: Byte
- \* Not including head switching time, read-after-write and write-after-read transient time.
- \* VFO Fast Sync (Raw Data and Servo) are signals in the drive.

Fig. 7.7-21 Fixed Sector Format Timing

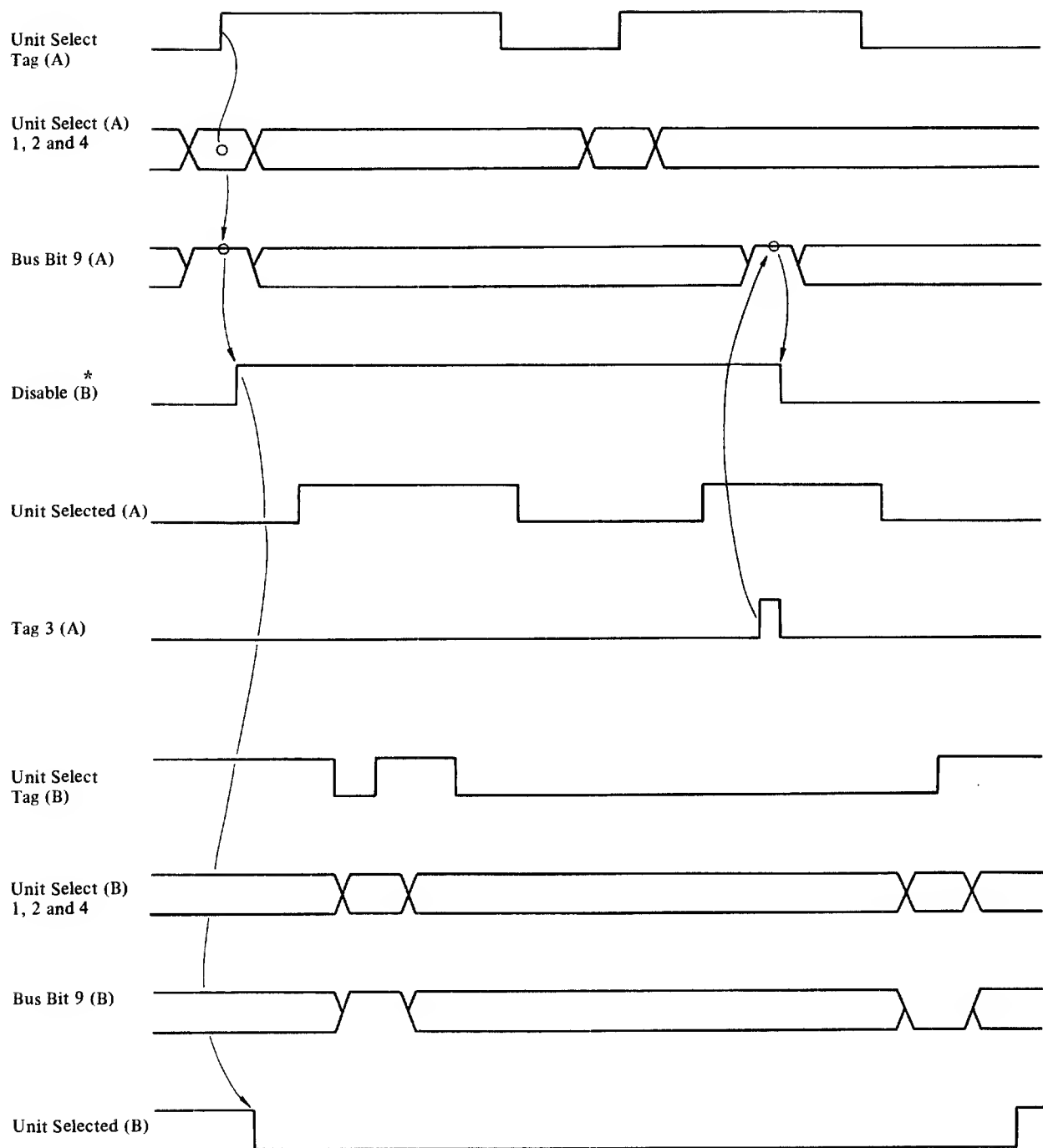




Note; Reserved (\*) is a signal within the drive.

Fig. 7.7-23 Unit Select Timing (Dual Channel Only)





- Note; (1) Disable (\*) is a signal within the drive.  
 (2) A sequence example of the above is as follows:  
 Channel B Select → Channel A Priority Select  
 → Channel B Priority Select Try → Channel  
 A Release → Channel B Select

Fig. 7.7-24 Priority Select Sequence (Dual Channel Only)

## 8.1 BLOCK DIAGRAM

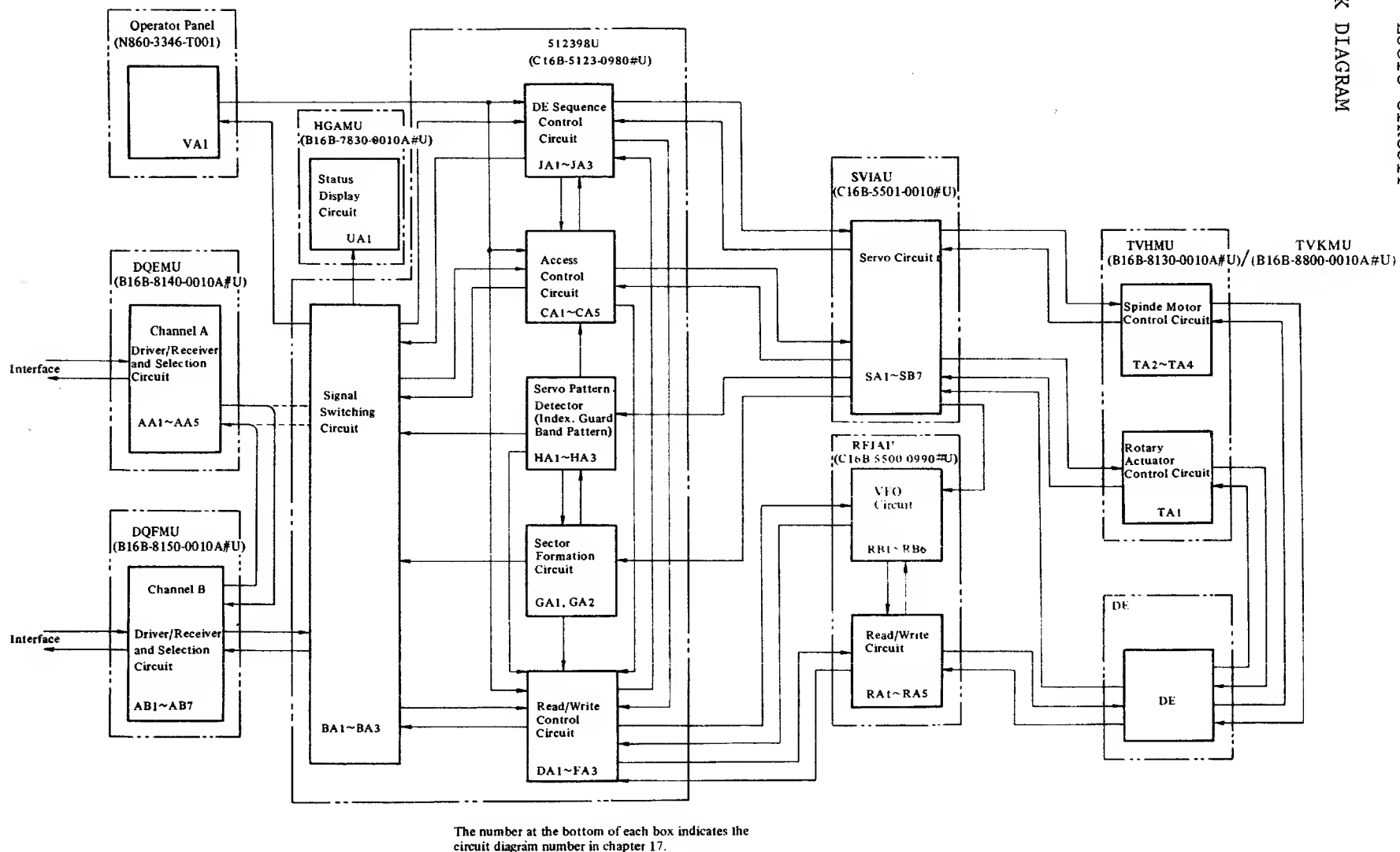


Fig. 8.1-1 Drive Circuit Configuration Diagram (Included Dual Channel Option)

## 8.2 DE SEQUENCE

The drive can execute instructions (TAG1, TAG2, TAG3) sent from the controller after the START switch on the operator panel is set to ON, the disk comes up to the rated speed, the head is moved from the CSS area to cylinder 00 (hereafter called sequence RTZ), and the disk becomes ready. The operations performed between the moment the START switch is set to ON and the moment the drive becomes ready is called the DE Start Sequence. When the START switch is set to OFF, the drive stops the rotation of the disk after the head is moved to the CSS area. The operations performed between the moment the START switch is set to OFF and the moment the disk stops is called the DE Stop Sequence.

Each of these sequences is divided into several states (five states for the DE Start Sequence, and three states for the DE Stop Sequence), which are determined by decoding DE sequence latches 1, 2, and 4 (hereafter called DESQL1, DESQL2, and DESQL4) and are named states 0 to 7 (hereafter called ST0 ~ ST7). Figure 8.2-1 shows the states of a drive.

### DE Start Sequence and Its States

#### (1) State 0

When power is turned on, DESQL1, DESQL2, and DESQL4 are reset by the Initial Reset signal (PWRST).

#### (2) State 1

When the START switch on the operator panel is set to ON in state 0 (STARTS is set high), the start latch (STARTL) is set and DESQL1 is set. At this time, if the Initial Good signal is low [INSTG = Hall Alarm signal is low (\*HALRM) and Motor Speed signal is low (\*MTRSP)], the DE sequence check latch (DESQCKL) is set, DESQL1 is reset, and the operation returns to state 0. When the START switch is set to ON again (OFF → ON), DESQCKL is reset and the operation enters state 1.

#### (3) State 3

When the INSTG state occurs, DESQL1 and DESQL2 are set in this order and the operation enters state 3. When DESQL2 is set, the disk starts rotation. When the state 3 signal (ST3) goes high, the Start Timer signal (STTMR) is set high,

causing the timer to be started. If the Run State Good signal (RNSTG = \*HALRM\* MTRSP) remains low about 60 seconds after it has started (EN60S), DESQCKL and DESQL4 are set and the operation enters state 7.

#### (4) State 2

If RNSTG is high when EN25S is high in state 3, DESQL1 is reset and the operation enters state 2.

The state 2 signal (ST2) goes high, causing the sequence RTZ (SQRTZ) operation to be started.

#### (5) State 6

The interrupt signal (ACCOMP) generated upon completion of the SQRTZ operation sets DESQL4 and the operation enters state 6. In this state, the Unit Ready signal may be sent to the controller.

If one of the following conditions occur during state 6, DESQL1 is set and the operation enters state 7:

- 1 The START switch on the operator panel is set to OFF.
- 2 The MTRSP signal goes low.
- 3 The HALRM signal goes high.

### DE Stop Sequence and Its States

#### (1) State 7

When the State 7 signal goes high, the ANGHM signal is set high, causing the head to start moving to the CSS area (GO HOME).

#### (2) State 5

The interrupt signal (GHCMP) generated upon completion of the Go Home operation resets DESQL2, and the operation enters state 5. The State 5 signal (ST5) causes the timer to be started.

#### (3) State 4

The EN11S signal generated upon completion of the timer operation resets DESQL1, and the operation enters state 4.

#### (4) State 0

The State 4 signal (ST4) resets DESQL4, and the operation enters state 0 to indicate the end of the DE Stop Sequence.

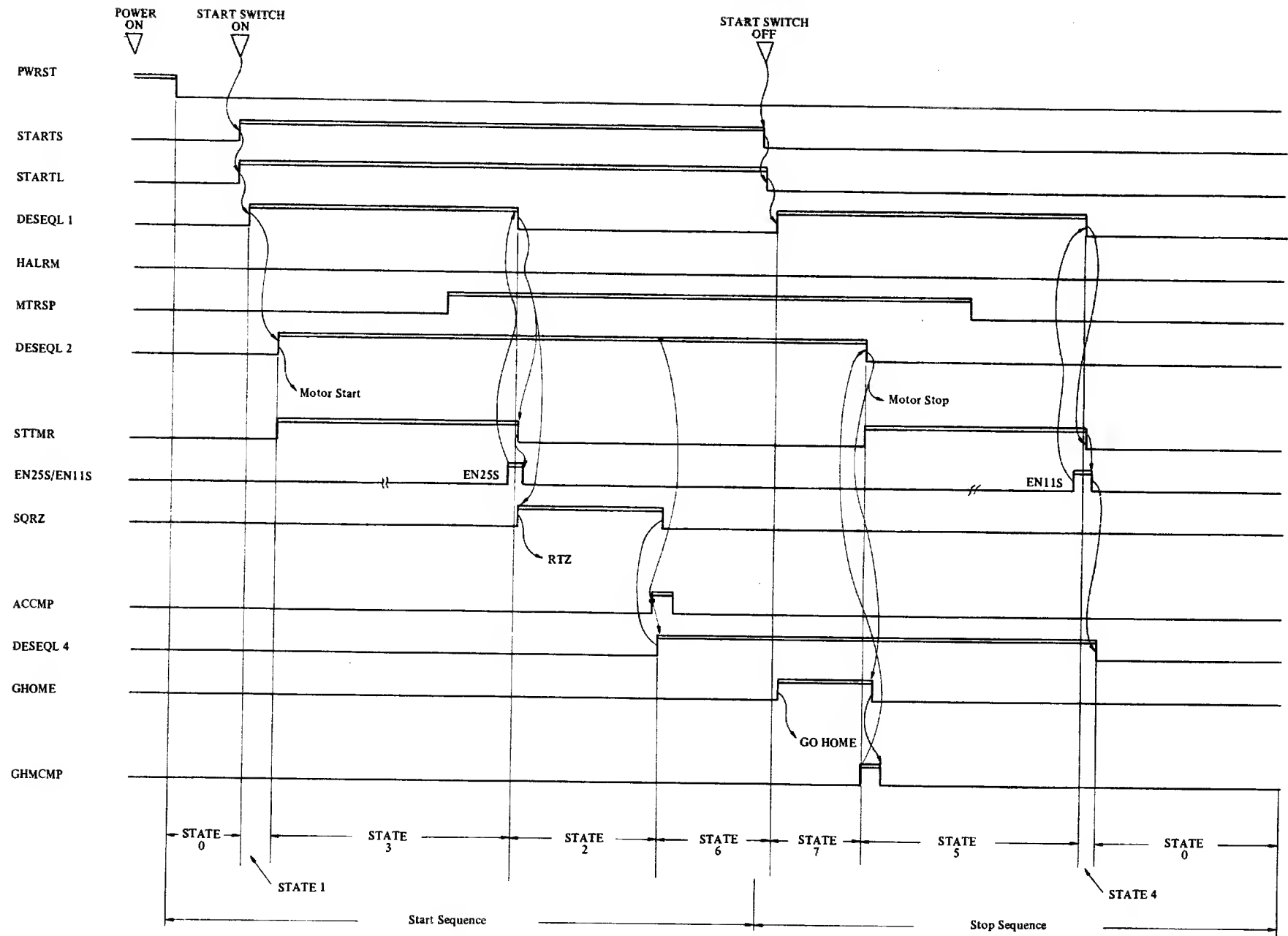


Figure 8.2-1 DE Start/Stop Sequence

### 8.3 SELECTION

The unit selection must be performed before instructions, such as Seek, Reed/Write, are sent from the controller.

When a drive receives Unit Select Tag (USLTG) and Unit Select 1, 2, 4 (USLCT1, USLCT2, and USLCT4), the drive compares it with its own address. The drive address is set by SW1 on the PCB, DQEMU. If the address sent from the controller matches the address of the drive when the Open Cable Detector (OCDTR) and Power Ready (PWRDY) signals are high, Select Latch (SLCTL) is set, Enable signal (ENABL) is generated, Unit Selected (SLCTD) is sent to the B-cable, and, at the same time, the driver/receiver for the A-cable are enabled for transmission.

While the drive is selected, instructions (Seek, RTZ, Read/Write, and others) may be received. The drive is released when one of USLTG, OCDTR, PWRDY goes low.

Figure 8.3-1 shows the unit selection sequence timing diagram.

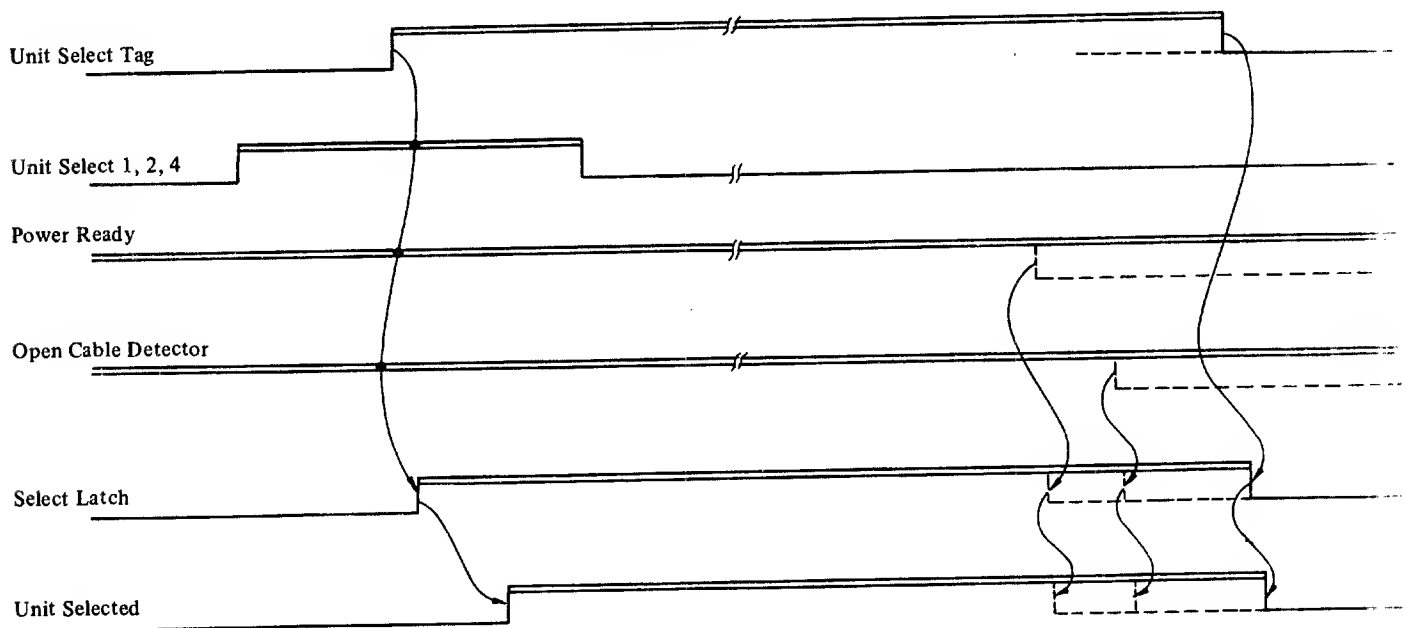


Figure 8.3-1 Unit Selection

## 8.4 OUTLINE OF ACCESS CONTROL

The access control circuit has five latches for controlling access operation. The operation modes and the outputs of the latches are as follows:

- (1) Sequence RTZ
- (2) System RTZ
- (3) Manual RTZ
- (4) Direct seek
- (5) Fine control

Table 8.4-1 Access Mode Latches

|                         |                |                         |                  |               |   |                 |                  |
|-------------------------|----------------|-------------------------|------------------|---------------|---|-----------------|------------------|
| REZERO<br>MODE<br>LATCH | SERVO<br>LATCH | LINEAR<br>MODE<br>LATCH | CONTROL<br>LATCH | WAIT<br>LATCH |   |                 |                  |
| Operation Mode          | STATE NO.      |                         |                  |               |   | Operation State |                  |
| Reset                   | 0              | 0                       | 0                | 0             | 1 | 0 8             | Wait State       |
| RTZ Operation           | 0              | 0                       | 0                | 0             | 0 | 0 0             | Start RTZ        |
|                         | 1              | 0                       | 0                | 0             | 0 | 8 0             | Move In          |
|                         | 1              | 0                       | 0                | 1             | 0 | 8 4             | Turn Around      |
|                         | 1              | 0                       | 1                | 1             | 0 | 8 6             | Move Out         |
|                         | 0              | 0                       | 1                | 1             | 0 | 0 6             | RTZ Linear Mode  |
|                         | 0              | 1                       | 1                | 1             | 0 | 0 7             | On track         |
|                         | Seek Operation | 0                       | 1                | 0             | 1 | 0               | 0 5              |
| 0                       |                | 1                       | 0                | 0             | 0 | 0 1             | Decelerate       |
| 0                       |                | 1                       | 1                | 0             | 0 | 0 3             | Seek Linear Mode |
| 0                       |                | 1                       | 1                | 1             | 0 | 0 7             | On track         |

## 8.5 SEQUENCE RTZ

In this mode, the head is moved from the CSS zone to cylinder 00 during the DE Start Sequence. Figure 8.5-1 shows the timing diagram.

### (1) State 08 (Wait state)

When Power On Reset goes high, Wait Latch (WAITL) is set high. Control Latch (CNTL), Linear Mode Latch (LNML), Servo Latch (SRVL), and Rezero Mode Latch (RZML) are low.

### (2) State 00 (Start RTZ)

When the State 2 (ST2) signal goes high in the DE Start Sequence, Sequence Rezero (SQRZ) and Any Rezero (ANYRZ) are set high and WAITL is set low.

### (3) State 80 (Move In)

When ANYRZ goes high, Start Rezero (STRZ) and Rezero Mode Latch (RZML) are set high. STRZ initializes the head address register and the cylinder address register. When RZML is set high, Rezero Mode (RZMOD) is set high and is sent to the servo control circuit.

At this time, the servo head is located at the innermost position of the CSS zone.

### (4) State 84 (Turn Around)

When guard band pattern 2 (GBP2) in the CSS zone is detected, Control Latch (CNTL) is set high and, at the same time, High Velocity Set (HVLST) and Move Out Gate (MVOTG) are set high and are sent to the servo control circuit. Upon reception of these signals, the servo control circuit moves the head from guard band pattern 2 (GBP2) to guard band pattern 1 (GBP1) at the REZERO High Speed.

### (5) State 86 (Move Out)

As the head is moved through the GBP2 zone in the outer direction, GBP1 is detected. Upon detection of GBP1, Linear Mode Latch (LNML) is set high and, at the same time, HVLST is set low.

From this moment, the head movement speed is reduced to the REZERO Low Speed, and the head is moved in the direction of cylinder 00 (outer direction).

At the end of the GBP1 zone is reached, Guard Band Latch (GRDBL) is set low and,



after that, the head speed is controlled by the Position Curve generated from the Position signal.

(6) State 06 (RTZ Linear mode)

When the head speed reaches the speed determined by the Position Curve, the servo control circuit sets End Decelerate (ENDDC) high and, then, RZML is set low.

When RZML goes low, the head is controlled in the Position Error Mode. If the head reaches within a specified distance from the center of cylinder 00 (On Track is high), the monostable multivibrator is activated. If On Track is high again at the end of the monostable multivibrator operation, Track Following Timer (TFTMR) is set high.

The operation mode controlled by Position Error is called Fine Control.

(7) State 07 (On Track)

If Valid Index (VLIX) goes high while TFTMR is high, Servo Latch (SRVL) is set high and Unit Ready, Seek End (SKEND), and On Cylinder (ONCYL) are sent to the controller.

If the sequence RTZ is unsuccessful, that is, if Overshoot Check (OVSCCK) or Time Out Check (TMOCK) is detected, Access Check (ACCK) is set high and the carriage is released. At this time, Unit Ready (UNRDY), Seek End (SKEND), and Seek Error are sent to the controller.

Over Shoot Check (OVSCCK) is set high when the head is moved at an abnormal speed during the RTZ operation (VG20I is set high if the speed exceeds 20 inches/second), or when Guard Band Pattern [Inner Guard Band Pattern (GBP2 and GBP1) or the Outer Guard Band Pattern (OGB)] is detected during the fine control, or when the head is not on the track and Track Crossing Pulse (TRXGP) is set high three or more times. Time Out Check (TMOCK) is set high if the operation is set high and the operation is not terminated within 250 ms.

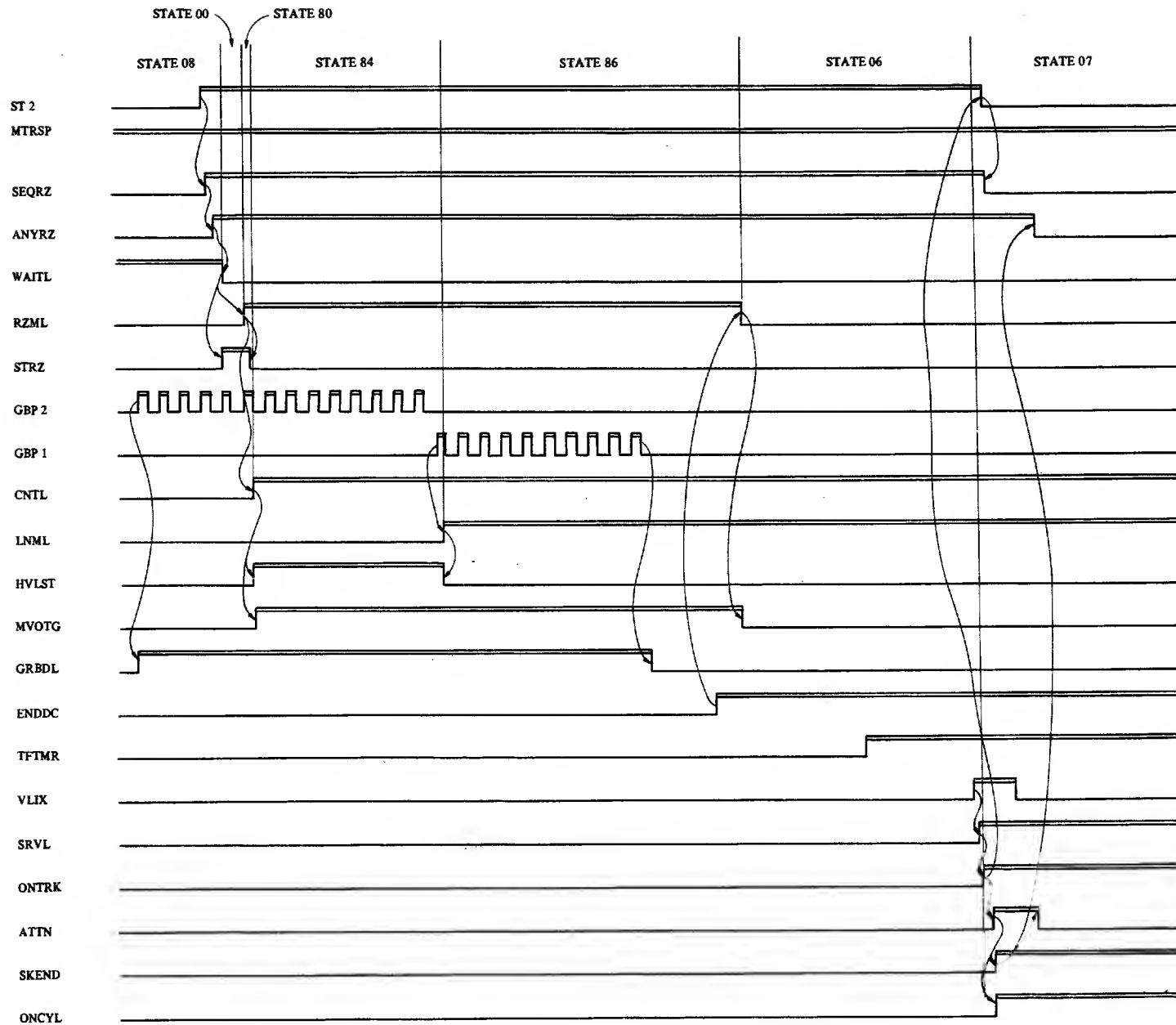


Figure 8.5-1 Sequence RTZ

## 8.6 SYSTEM RTZ/MANUAL RTZ

In the system RTZ (SYSRZ) and manual RTZ (MRTZL) modes, the head is moved to cylinder 00 regardless of the position at which the head is currently located. The system RTZ operation (SYSRZ) is started, upon receipt of Tag 3/bit 6 (RTZ) from the controller, when the drive is selected and is not performing the seek or RTZ operation or when a seek error occurs. The manual RTZ operation (MRTZL) is started by switch 2 (SW2) on the PCB, HGAMU, when the drive is not performing the seek, RTZ, offset, or read/write operation. Figures 8.6-1 and 8.6-2 show how SYSRZ and MRTZL are started, respectively. Figure 8.6-3 shows the sequence that is performed after RZML is set high.

### (1) State 08 (Wait state)

When SYSRZ or the MRTZL operation is performed, ANYRZ is set high. Then, WAITL is set high, and the access mode latches (RZML, SRVL, LNML, CNTL) and Seek Error (Access Check: ACCCK) are set low.

### (2) State 00 (Start RTZ)

When the SYSRZ operation is performed, the access mode latches are set low and, then, WAITL is set low.

When the MRTZL operation is performed, WAITL is set high while SW2 is high.

When SW2 goes low, WAITL is set low.

### (3) State 80 (Move In)

When WAITL is set low, STRZ and RZML are set high.

Before the head detects Guard Band Patterns 1 and 2 (GBP1 and GBP2), the carriage is moved in the inner direction at the RTZ High Speed. When the carriage passes cylinder 00 and GBP1 is detected, Guard Band Latch 1 is set high and the speed is reduced to the low speed.

If the head is on GBP1 at the start of this state, the carriage is moved at the low speed from the beginning.

### (4) State 84 (Turn Around)

When the head passes GBP1 and detects GBP2, CNTL is set high and, at the same time, HVLST and MVOTG are set high. In this case, the head is moved at the high speed to the outer direction.

(5) State 86 (Move Out)

Same as that of sequence RTZ.

(6) State 06 (Rezero Linear Mode)

Same as that of sequence RTZ.

(7) State 07 (On Track)

Same as that of sequence RTZ.

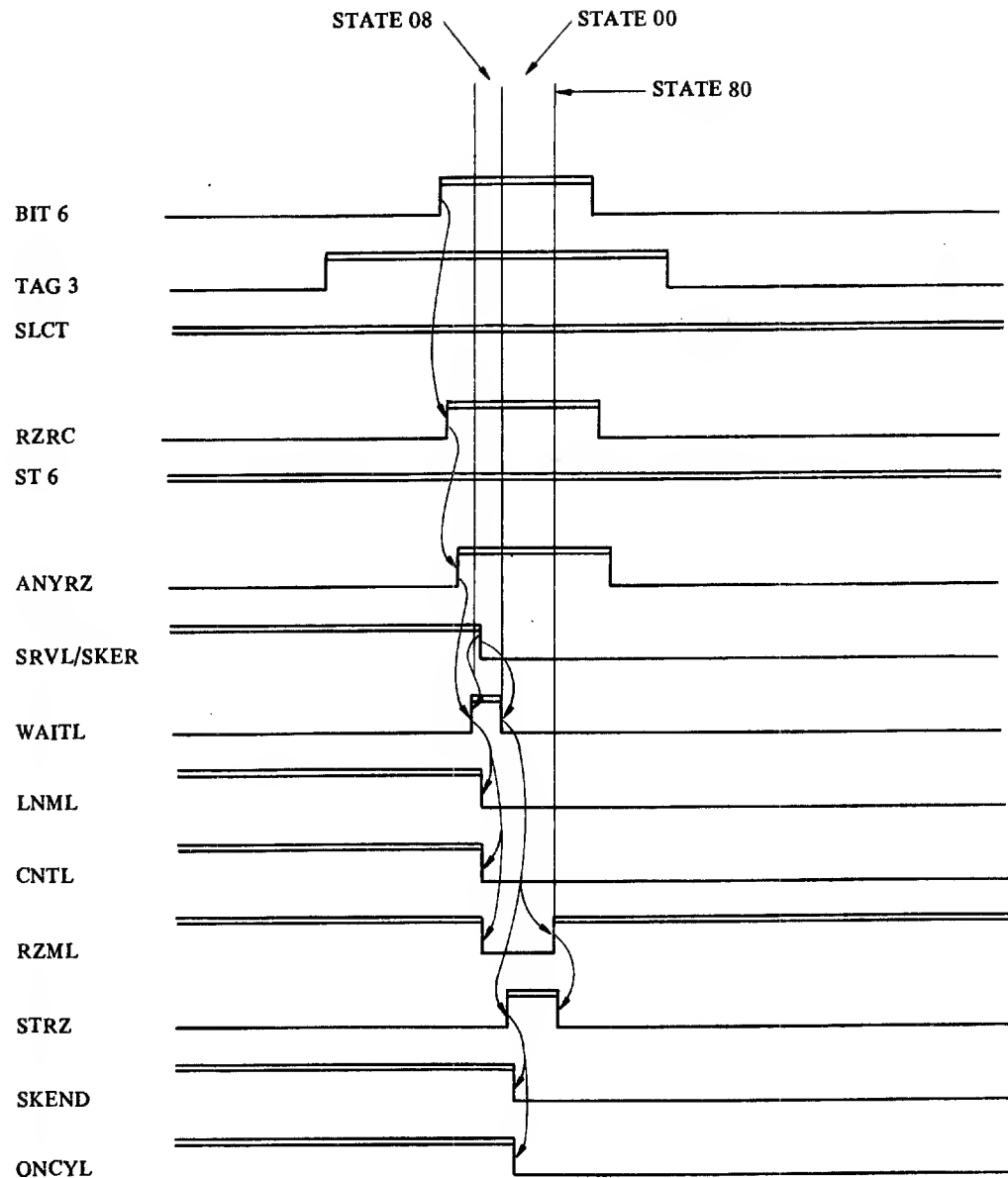


Figure 8.6-1 System RTZ Sequence

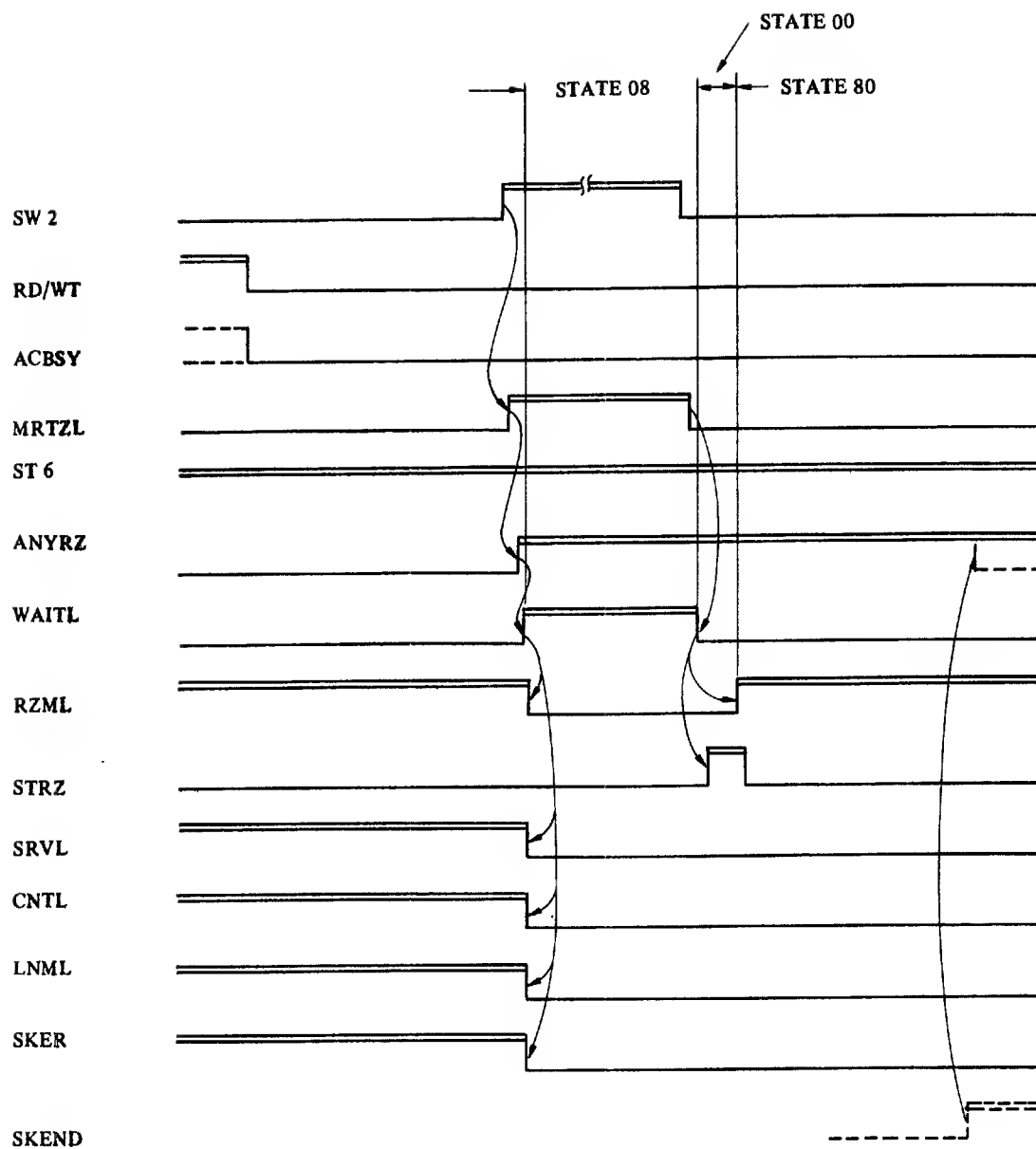


Figure 8.6-2 Manual RTZ Sequence

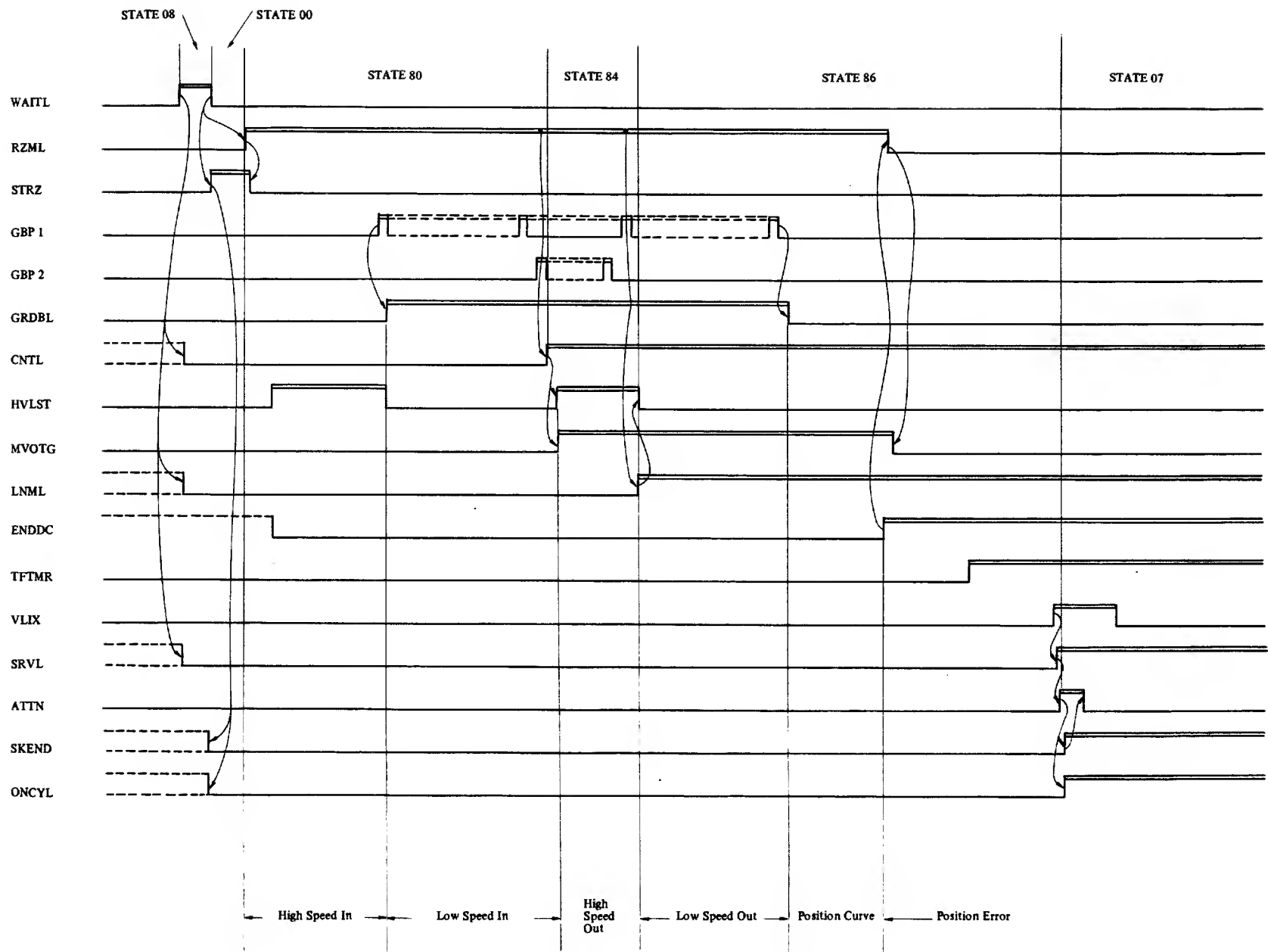


Figure 8.6-3 System/Manual RTZ Sequence (Continued)

## 8.7 SEEK

The head is moved to the cylinder specified by TAG1/bits 0 - 9 sent from the controller. Figure 8.7-1 shows the timing diagram.

### (1) State 05 (Accelerate)

When TAG1 goes high, the contents of bits 0 to 9 are set in the new cylinder address register (NCAR). The address of the cylinder on which the head is currently located is stored in the present cylinder address register (PCAR). The difference between the address stored in the NCAR and that in the PCAR is calculated and is output in the binary code (D1 - D128). If the difference is 144 or greater ( $\text{NCAR} - \text{PCAR} > 144$ ), D1 - D128 is set to a value of all 1 bits and is sent to the servo control circuit. The servo control circuit forms the desired speed curve according to the value indicated by D1 - D128.

If the value indicated by the NCAR is greater than that indicated by the PCAR, Move Out Gate (MVOTG) is set high to cause the head to be moved in the outer direction; conversely, if the value indicated by the NCAR is smaller than that indicated by the PCAR, MVOTG is set low to cause the head to be moved in the inner direction.

Then, when TAG1 goes low, Set CAR Off Pulse (SCAROFF) is set high, SKEND, ONCYL, TFTMR, and LNML are set low, and Access Mode (ACCMD) is set high.

The servo control circuit moves the head according to the desired speed curve and generates Track Crossing Pulse (TRXGP) whenever the head crosses a cylinder. TRXGP is sent to the PCAR to increment the register when the head is moved in the outer direction, or to decrement the register when the head is moved in the inner direction. Thus, the output of the difference counter (D1 - D128) is decremented by one at a time.

### (2) State 01 (Decelerate)

If the head is moved at a speed higher than that indicated by the desired speed curve, the servo control circuit generates End Accelerate (ENDAC) and sets CNTL low. The speed of the head is then reduced so that the head is moved according to the desired speed curve.

### (3) State 03 (Seek Linear Mode)

When the head detects On Cylinder at the desired cylinder (NCAR=PCAR), the servo control circuit generates End Decelerate (ENDDC) and, at the same time, starts the 2.5 ms-timer and sets LNML high. Then, the operation mode of the head is changed from the position curve control mode to the position error control mode.

### (4) State 07 (On Track)

If the head is on the desired track when the operation of the 2.5 ms-timer is ended, TFTMR is set high. CNTL is set high and, at the same time, SKEND and ONCYL are set high. This means that the seek operation is terminated. When a no-motion seek command is issued from the controller, the 5  $\mu$ s-timer is activated and, at the completion of the timer, SKEND and ONCYL are set high.

If an illegal cylinder address is sent (a value greater than 842 for M2351A, or a value between 842 and 895 for M2351AF, SKER and SKEND are set high after about 5  $\mu$ s. If the seek operation is not terminated normally, that is, if the seek operation is not terminated within 250 ms (TMOCK), or if the Inner or Outer Guard Band are detected during the seek operation, or if TRXGP is detected three times or more after the head is reached to the desired cylinder (OVSCK), SKER and SKEND are set high.

When SKER is set high, the head is released.



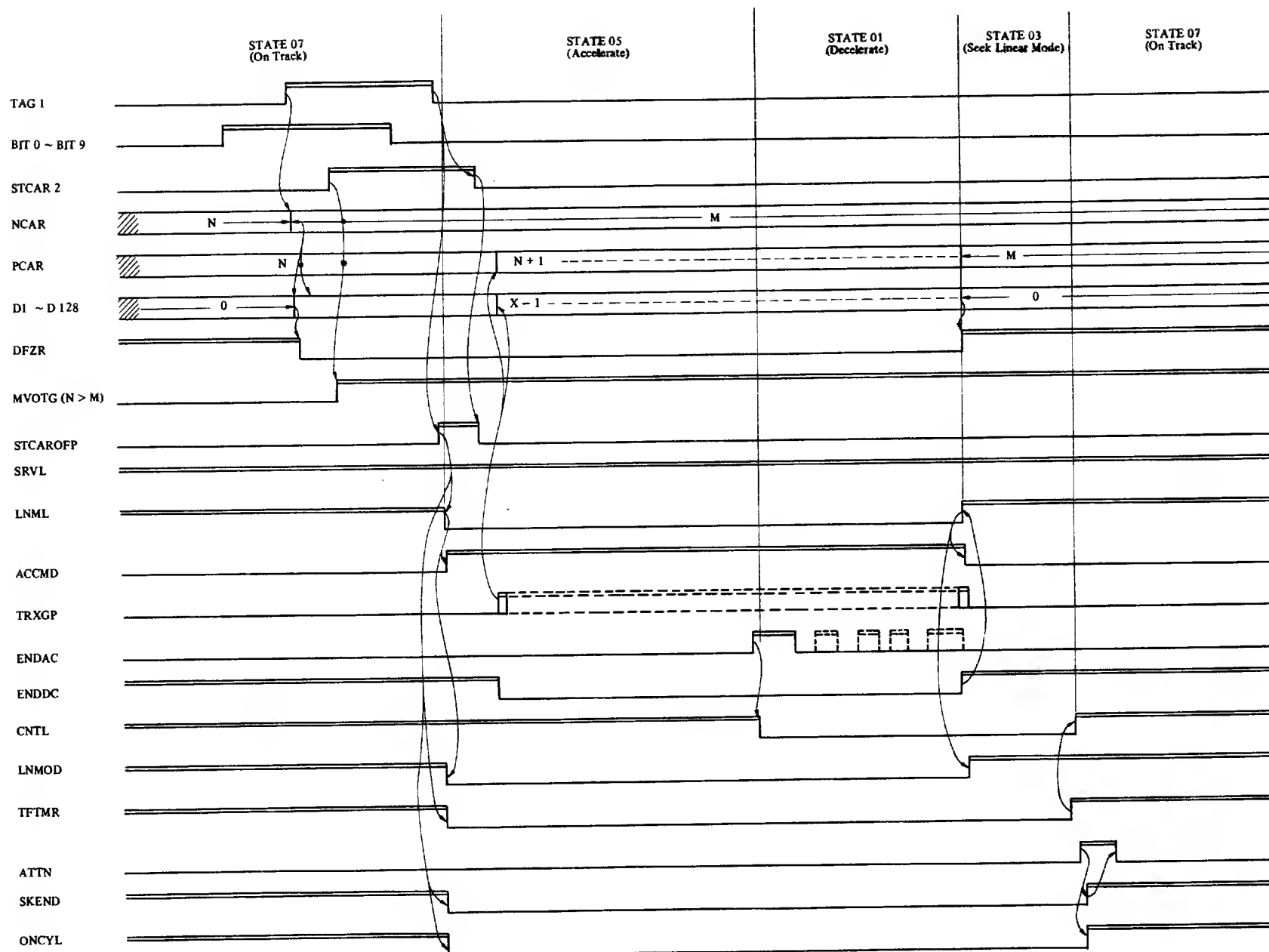


Figure 8.7-1 Seek Sequence

## 8.8 OFFSET

The head being at the center of a track (On Track) is moved 100 $\mu$  inches in the direction specified by bit 2 or 3 of TAG3 sent from the controller. The fine control method is used in this operation mode. Figure 8.8-1 shows the timing diagram.

While the drive is selected (SLCT), Offset Plus (OFSTP) is set high when bit 2 of TAG3 is set to 1 by the controller and, at the same time, Offset Out (OFSOT) is set high. If the drive is not in the abnormal condition (ABN) at this time, Offset Active (OFACT) is set high and, at the same time, Difference 16 (GD16) is set high. Then, the servo control circuit moves the head in the outer direction; i.e., the servo control circuit starts the offset operation and moves the head to the location 100 $\mu$  inches outward of the on-track position. This operation is terminated within 5 ms.

When OFACT goes high, Offset Active Pulse (OFACP) is set high and the 5 ms-timer is started (M5MS). At the same time, Seek End (SKEND) and On Cylinder (ONCYL) are set low. SKEND and ONCYL are set high when the timer operation is terminated.

When bit 3 of TAG3 is set to 1, Offset Minus (OFSTM) is set high and, by holding OFSOT low, the head is moved in the inner direction.

When bit 2 or bit 3 of TAG3 is set to 0 and OFSTP, OFSTM, OFSTA, and GD16 are set low, the head is returned to the on-track position. This operation is terminated within 5 ms.

When OFACT goes low, OFACP is set high, the 5 ms-timer (M5MS) is started and, at the same time, SKEND and ONCYL are set low. When M5MS goes low, SKEND is set high and, if the head is at the on-track position, ONCYL is set high.

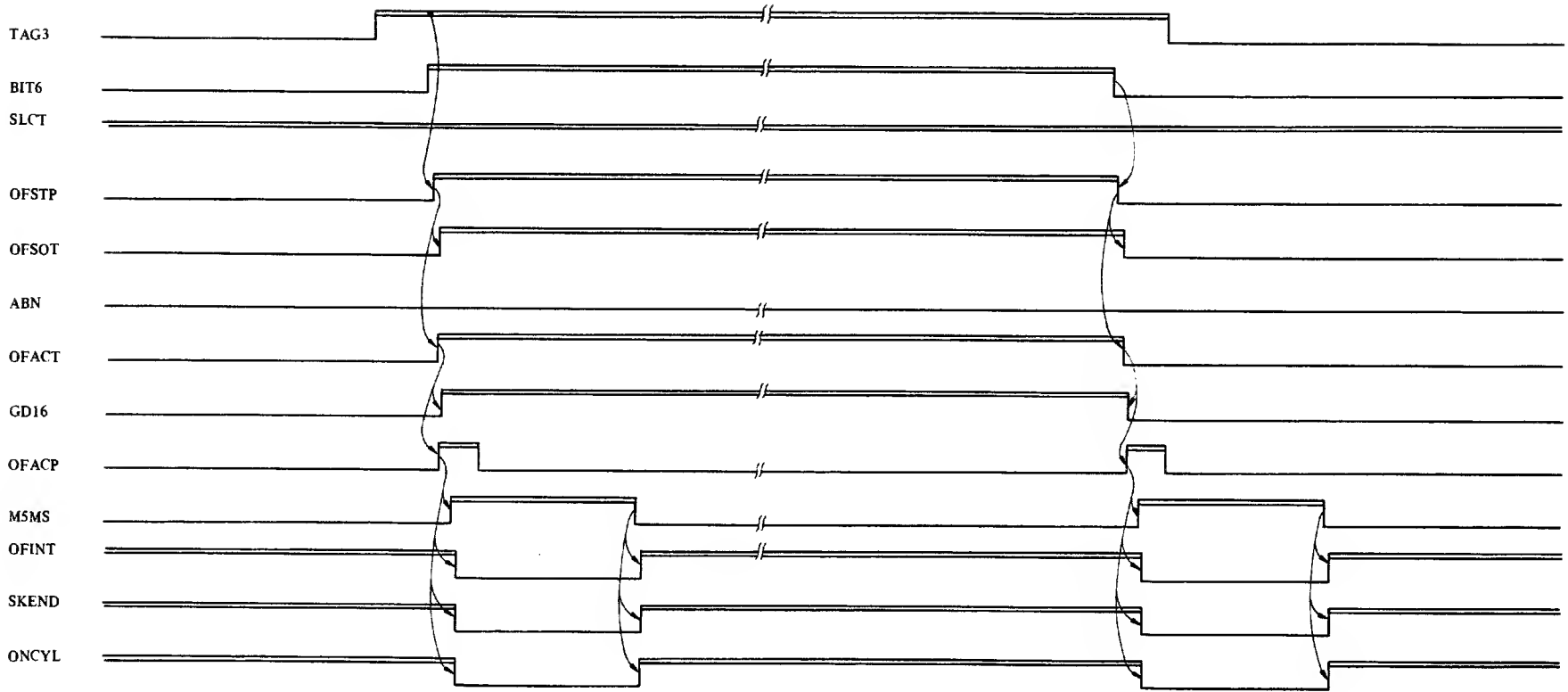


Figure 8.8-1 Offset Sequence

## 8.9 FAULT AND ERROR DETECTION

Faults and errors detected in the drive are displayed by the maintenance - aid LEDs on the indicator unit (HGAMU; B16B-7830-0010A/U) and reported to the controller through the interface lines.

### (1) Fault Register

If the following errors occur, the Fault register will be set and Fault line will be enabled.

Table 8.9-1 Write/Read Check Conditions

| No. | Write/Read Check State      | Conditions                                                                                                   | MD 0  | LP  |
|-----|-----------------------------|--------------------------------------------------------------------------------------------------------------|-------|-----|
| 1   | Index Check                 | $(RG+WG) \cdot IDXCK$                                                                                        | Bit 1 | LP1 |
| 2   | Control Check               | $RG \cdot WG$<br>$OFACT \cdot WG$<br>$RONLY \cdot WG$                                                        | Bit 2 |     |
| 3   | Multi-Head Check            | $(RG+WG) \cdot MCPSL$                                                                                        | Bit 4 |     |
| 4   | Head Short Check            | $(RG+WG) \cdot HDSHT$                                                                                        | Bit 8 |     |
| 5   | Write Current On Read Check | $RG \cdot MUSFV$                                                                                             | Bit 1 | LP2 |
| 6   | Write Transition Check      | $WG \cdot \overline{AMCTL} \cdot MUSFV$                                                                      | Bit 2 |     |
| 7   | Delta I Write Check         | $WG \cdot DIECK$                                                                                             | Bit 4 |     |
| 8   | Servo Off-Track             | $WG \cdot \overline{RWCAP} \cdot (\overline{URDY} + \overline{TFTMR} + ACCK)$<br>$RG \cdot \overline{EQUAL}$ | Bit 8 |     |

These fault status can be cleared by one of the followings;

- ① Depressing the Fault Clear switch on the operator panel
- ② Fault Clear signal sent from the controller

### (2) Seek Check Latch

If seek error occurs in the drive, the error will set Seek Check Latch, enabling Seek Error to the controller, and light the maintenance-aid LED.

Table 8.9-2 Seek Error Fault Conditions

| No. | Access State         | Conditions                                                              | MD 1  | LP  |
|-----|----------------------|-------------------------------------------------------------------------|-------|-----|
| 1   | Access Timeout Check | Timeout in direct or RTZ seek                                           | Bit 2 | LP1 |
| 2   | Over Shoot Check     | Any Guard Band in direct seek, or Over track-crossing pulse in settling | Bit 4 |     |

The following explains the servo format and how the head positioning control circuit operates:

The seek control operation and the rezero seek control operation are outlined first, followed by the function of each component of the head positioning control circuit, and the spindle motor control method.

### 9.1 DATA AND SERVO ZONE

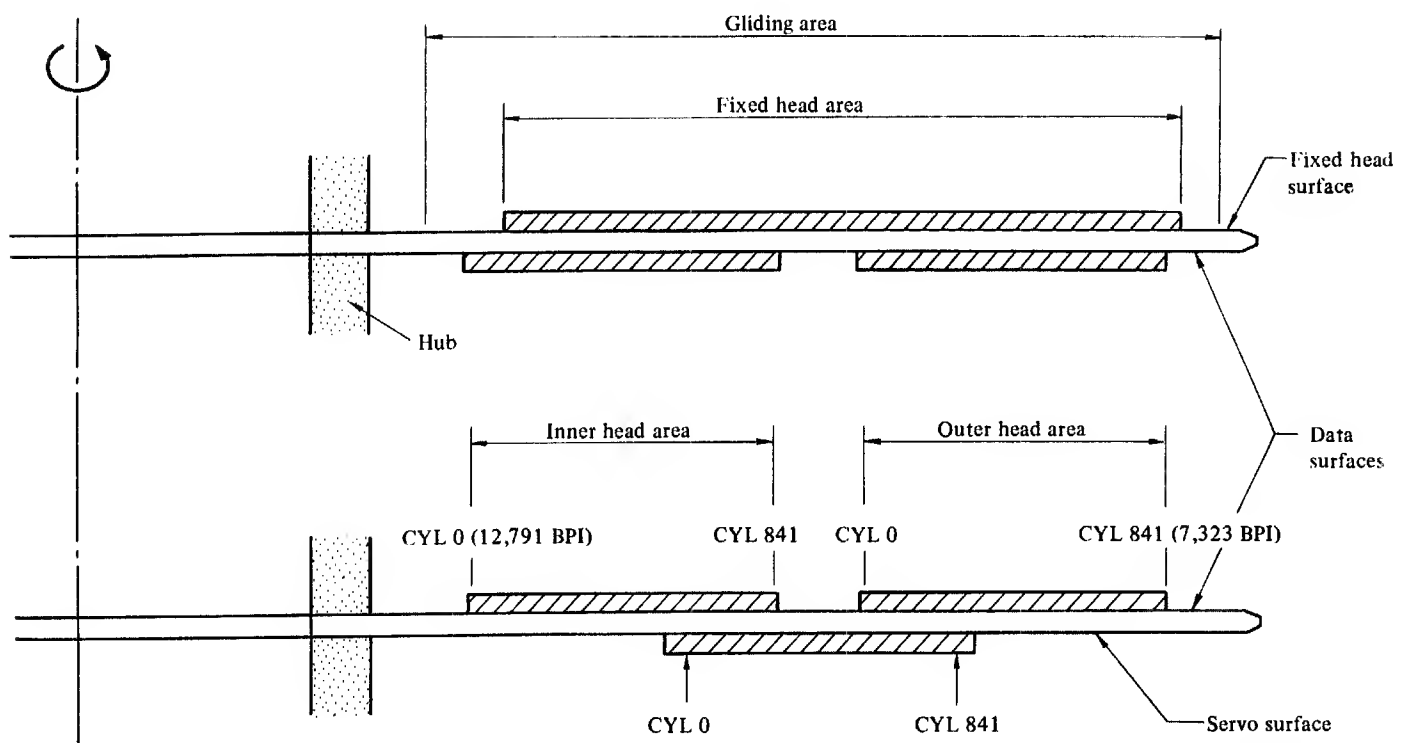


Figure 9.1-1 Data and Servo Area Locations

Though the rotational angle of arm assemblies is constant for all tracks ( $2.27 \times 10^{-4}$  radians per track), the track pitch for the servo, inner, and outer R/W heads varies as shown in Figure 9.1-2 depending on the mechanical arrangement of the head-arm and the cores.

The track width of the inner R/W head is made wider than that of the outer R/W head to avoid decrease of time margin for the read operation.

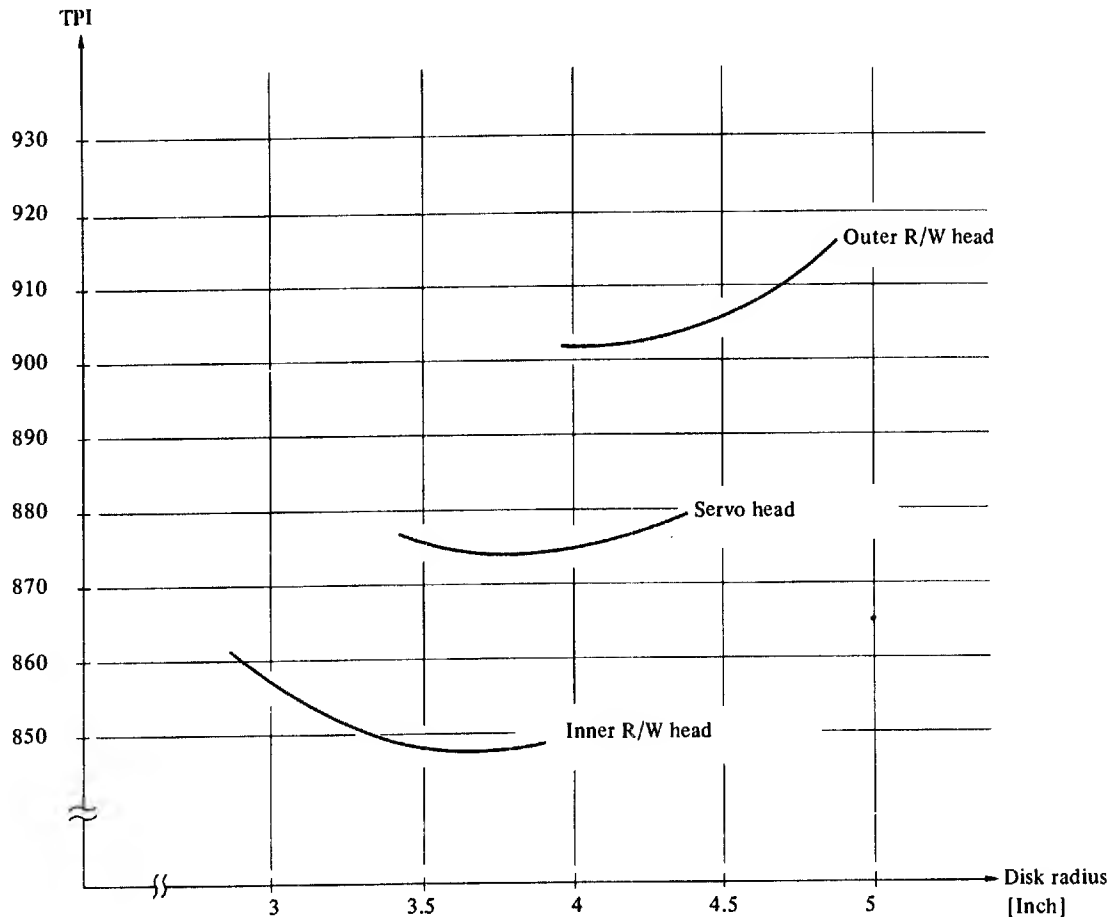


Figure 9.1-2 Track Pitch

## 9.2 SERVO FORMAT

The two-phase composite servo signal is pre-recorded on the bottom servo surface. This signal is read by the servo head, and the index signal, sector count clock signal, read/write PLO signal, and two types of position signals, 90 degrees out of phase with each other, are generated. The two-phase servo signal makes the effective track width of the servo signal ( $29\mu\text{m}$ ), one-half of the actual track width ( $58\mu\text{m}$ ).

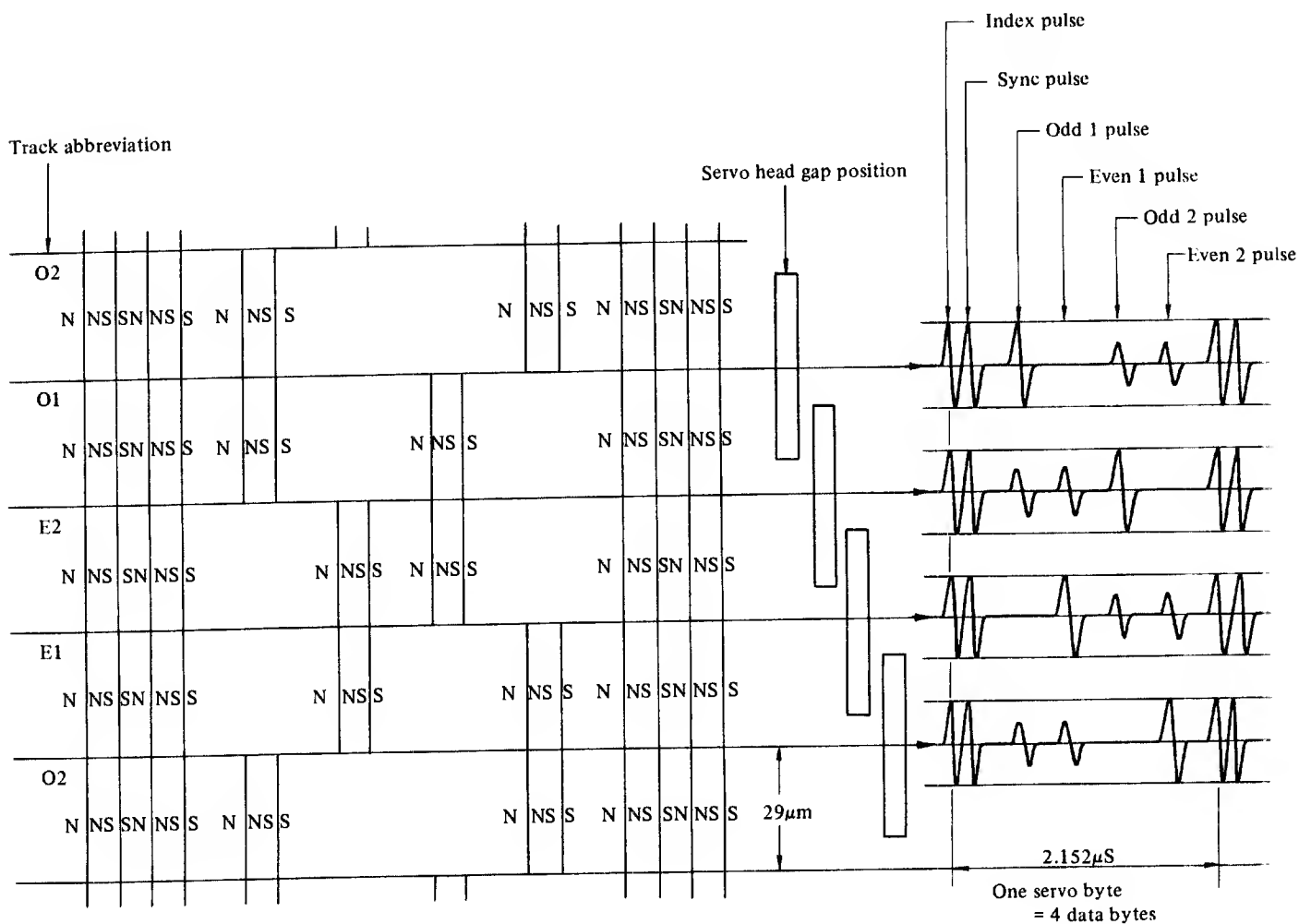


Figure 9.2-1 Magnetized Pattern of Two-phase Servo Signal and Read Signal



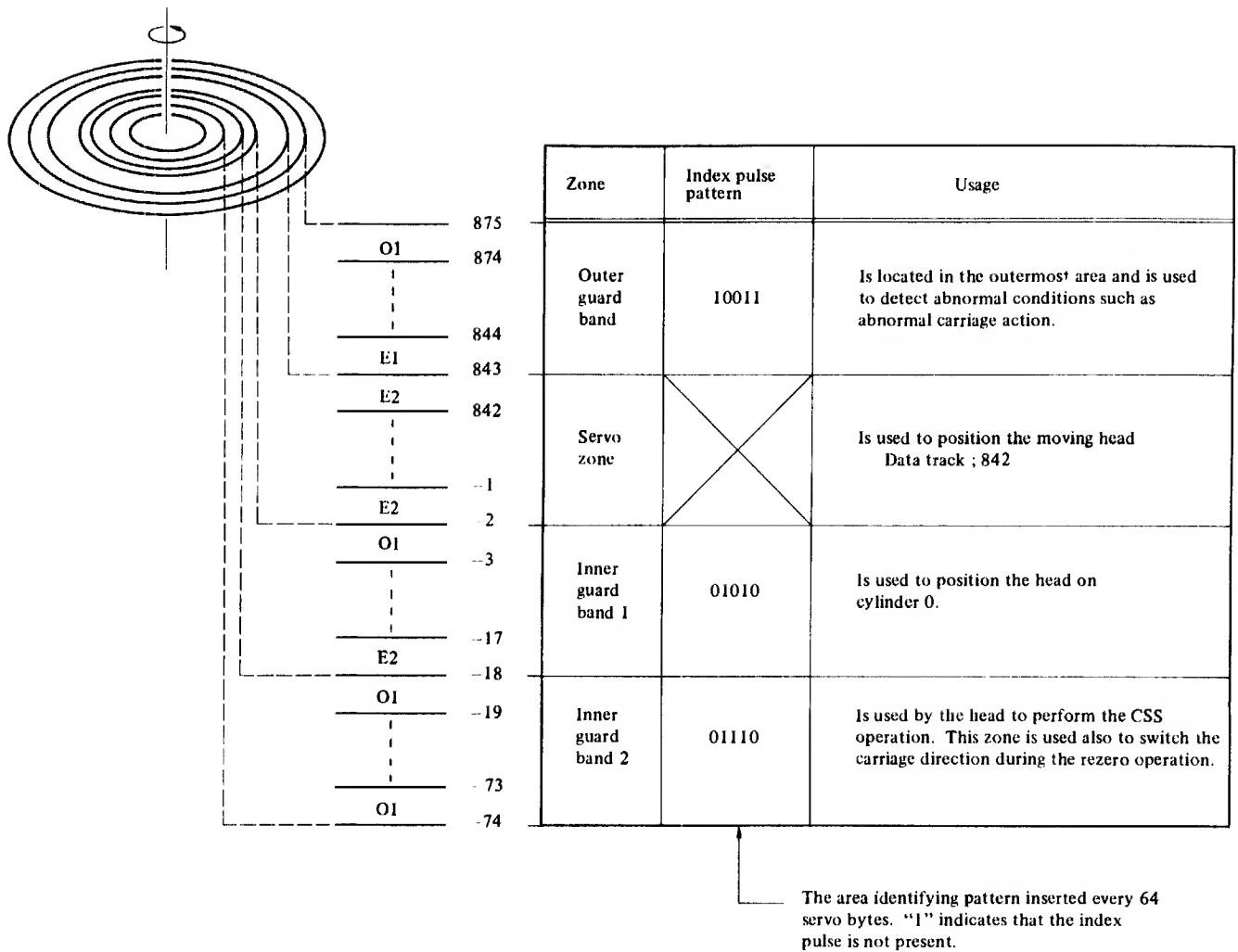


Figure 9.2-2 Zone Allocation on Servo Surface

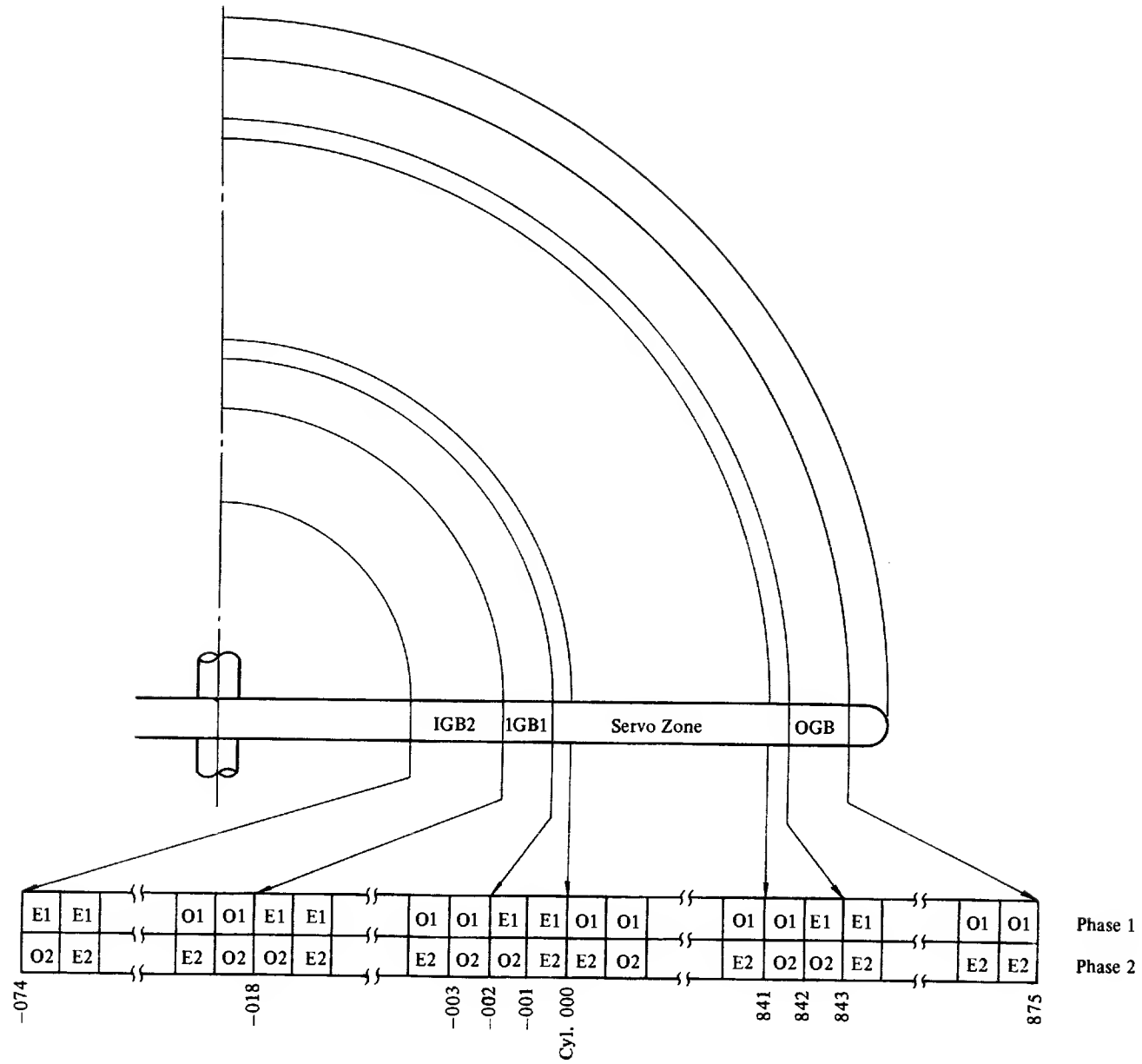
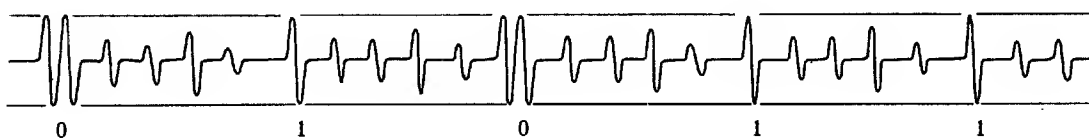


Figure 9.2-3 Servo Track Configuration

## Index pulse pattern

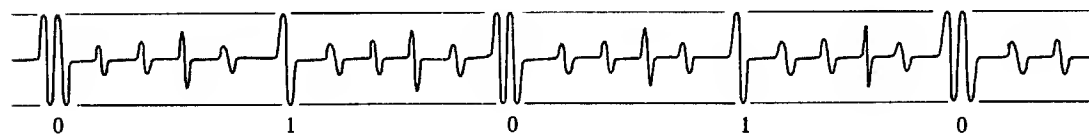
Each area is identified by the index pulse (0: present, 1: absent) preceding the sync pulse. The valid index pattern, detected once per rotation, indicates the physical starting point. Inner Guard Band 1 and 2 and the Outer Guard Band are written every 64 servo bytes; this means that there are 110 locations at which these patterns are written. However, if any of the 110 locations coincides with the location at which the valid pattern is written, the valid index pattern is effective.



Valid index pattern



Inner Guard Band 2 pattern



Inner Guard Band 1 pattern



Outer Guard Band pattern

Figure 9.2-4 Index Pulse Pattern

### 9.3 SEEK CONTROL OPERATION

The seek control operation is classified roughly into the coarse control operation and fine control operation.

#### (1) Coarse control operation

The coarse control operation is performed to move the head to the desired cylinder position. That is, the head is moved with a speed feedback loop at a high speed by comparing the target speed, derived from the position difference between the desired position sent from the logic circuit and the actual position, with the actual speed derived from the position signal read from the servo surface with the servo head.

The speed is decreased as the position difference is reduced and, when the head reaches near the neighborhood of the desired cylinder, the speed becomes very slow.

#### (2) Fine control operation

When the head approaches the desired cylinder and the difference between the desired position and the current position is within the specified range (on track), the coarse control operation is switched to the fine control operation. During the fine control operation, the position signal is fed back to ensure that the head is always on the desired cylinder notwithstanding mechanical vibration and temperature change.

The speed signal is used as the damping factor. The signal generated by integrating the position signal is also used to increase stiffness.

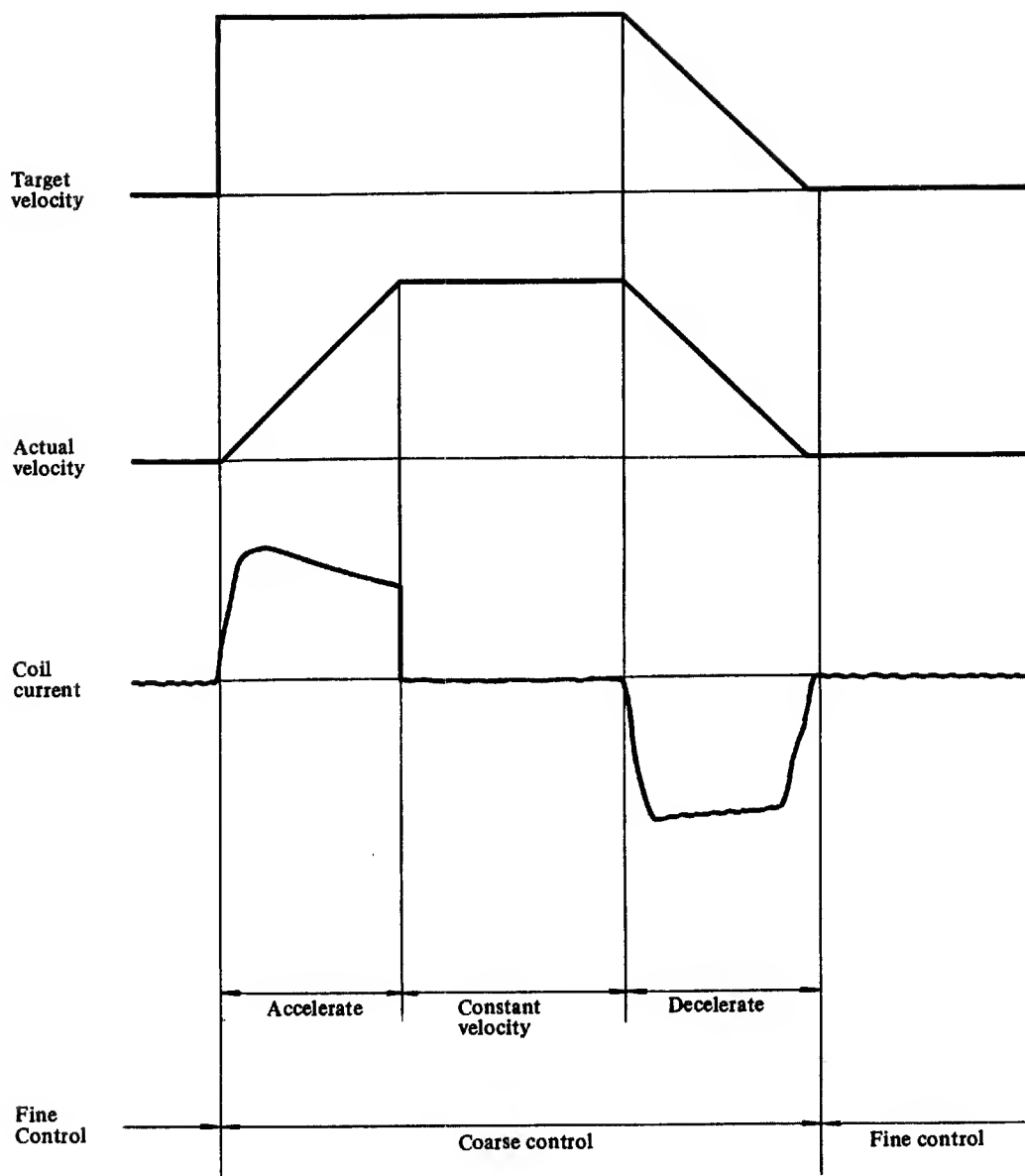


Figure 9.3-1 Seek Control

#### 9.4 REZERO CONTROL OPERATION

The head is returned to the reference cylinder (cylinder 0). The rezero seek operation is classified into the coarse control operation and the fine control operation as with the seek control operation; however, unlike the seek control operation, the target speed is determined by the signal generated by the reference voltage. The following explains how the rezero seek operation is performed, assuming that the head is not in the Inner Guard Band.

##### (1) High Speed In (HSPIN)

The head is moved in the inner direction about 8 inches per second until Inner Guard Band 1 (IGB1) is detected.

##### (2) Low Speed In (LSPIN)

The head is moved in the inner direction at about 2.5 inches per second between the moment when IGB1 is detected in the neighborhood of cylinder-2 (minus 2) and the moment when Inner Guard Band 2 (IGB2) is detected.

##### (3) High Speed Out (HSPOT)

The direction in which the head is to be moved is inverted, and the head is moved in the outer direction at about 3.5 inches per second between the moment when IGB2 is detected in the neighborhood of cylinder-18 (minus 18) and the moment when IGB1 is detected.

##### (4) Low Speed Out (LSPOT)

The head is moved in the outer direction at about 0.8 inches per second after being returned to IGB1.

##### (5) Rezero Out (RZOUT)

When the head enters the servo zone from IGB1 after it travels in the neighborhood of cylinders-2 (minus 2), the head is moved to cylinder 0 with the target speed signal generated from the position signal.

(6) Fine control

After On Track is detected when the head is in the neighborhood of cylinder 0, the Position control is performed in the same manner as the seek control operation.

The rezero operation is performed from (2) if the head is to be returned from IGB1, or from (3) if the head is to be returned from IGB2; after that, the same control method is performed until the head is positioned on cylinder 0.

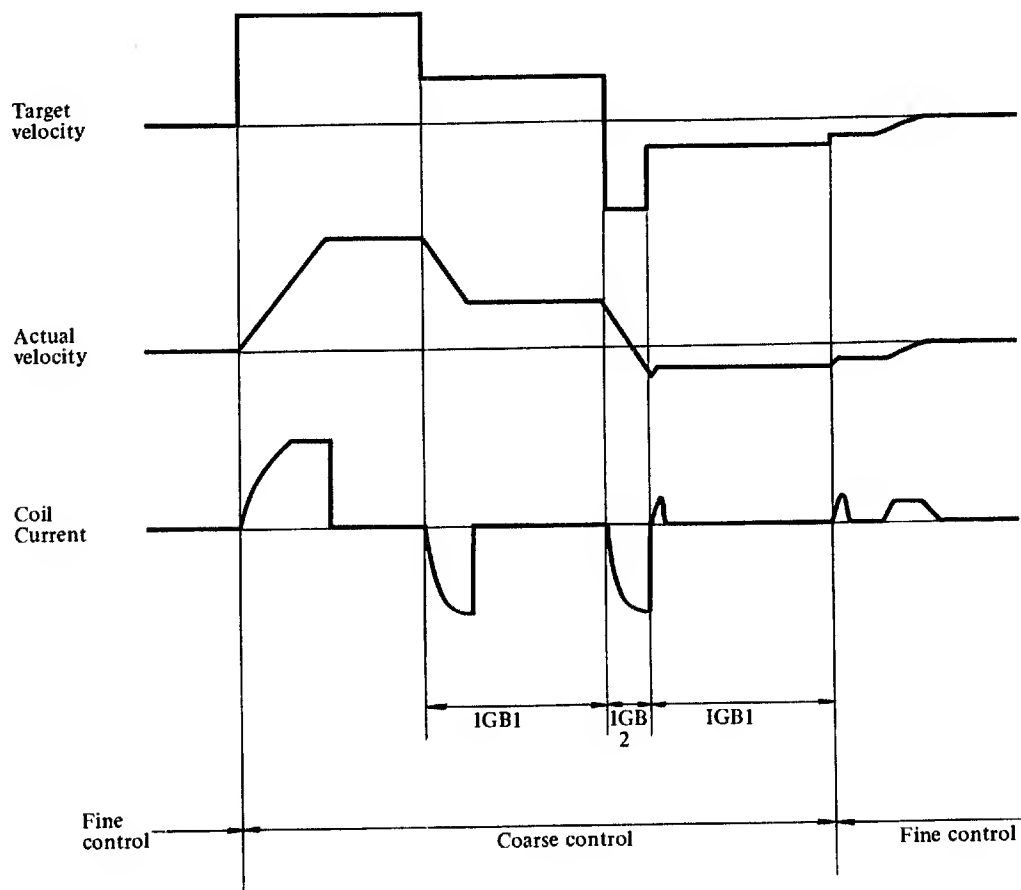


Figure 9.4-1 Rezero Control

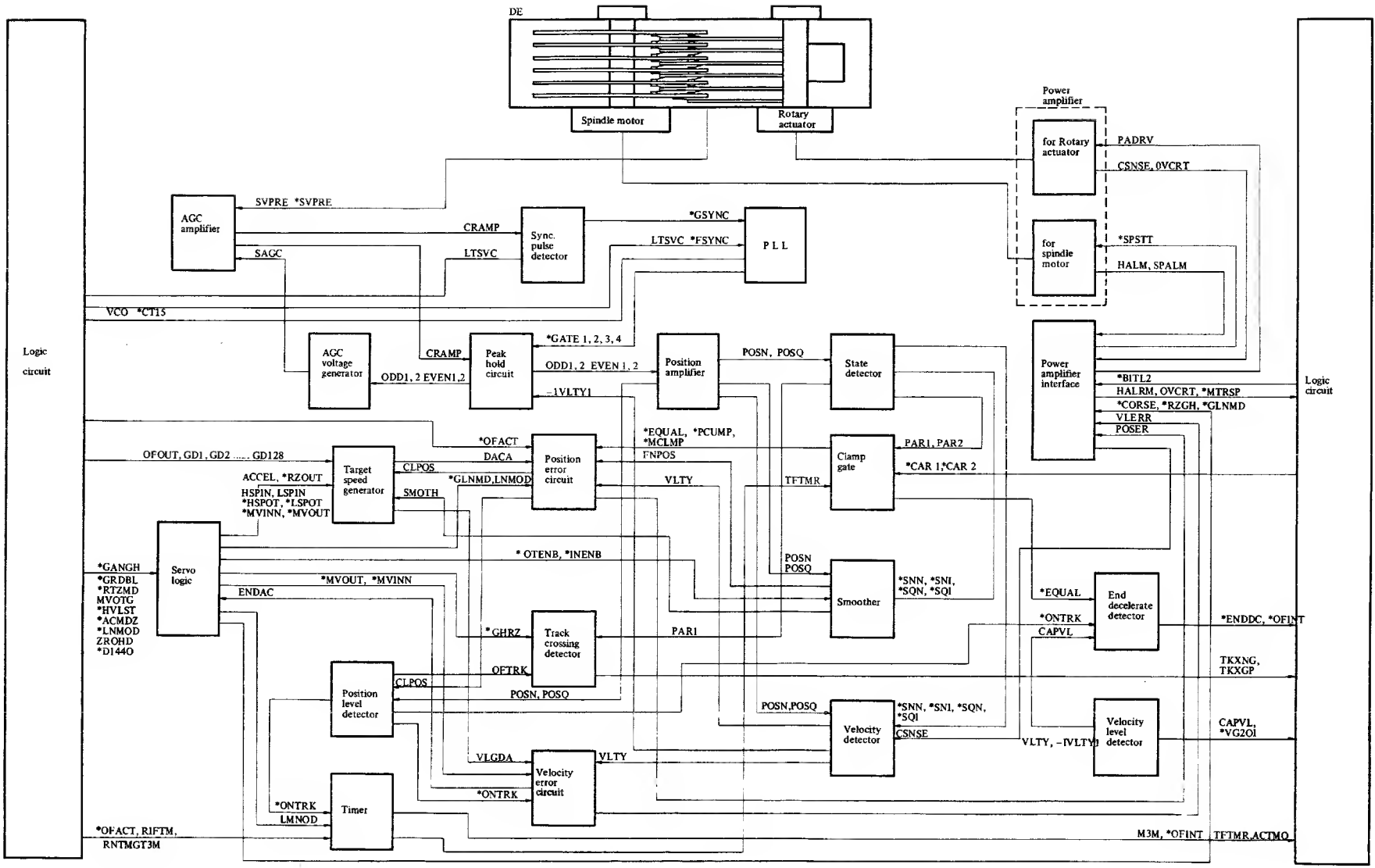


Figure 9.5-1 Servo Block Diagram

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(1) AGC amplifier

The AGC amplifier amplifies the output signal from the servo head (SVPRE and \*SVPRE) to generate the carrier amplifier signal (CRAMP). The amplifier gain is controlled by the output (SAGC) of the AGC voltage generating circuit to compensate for level fluctuation on the servo surface.

(2) Peak hold circuit

The peak hold circuit receives gate signals (\*GATE1 - 4) from PLL to sample ODD1, EVEN1, ODD2, and EVEN2 pulse from the output of an AGC amplifier (CRAMP). This circuit uses the output (-1 VLTY 1) from the speed detect circuit in order to vary the discharge time constant of the sampling circuit according to the head travelling speed.

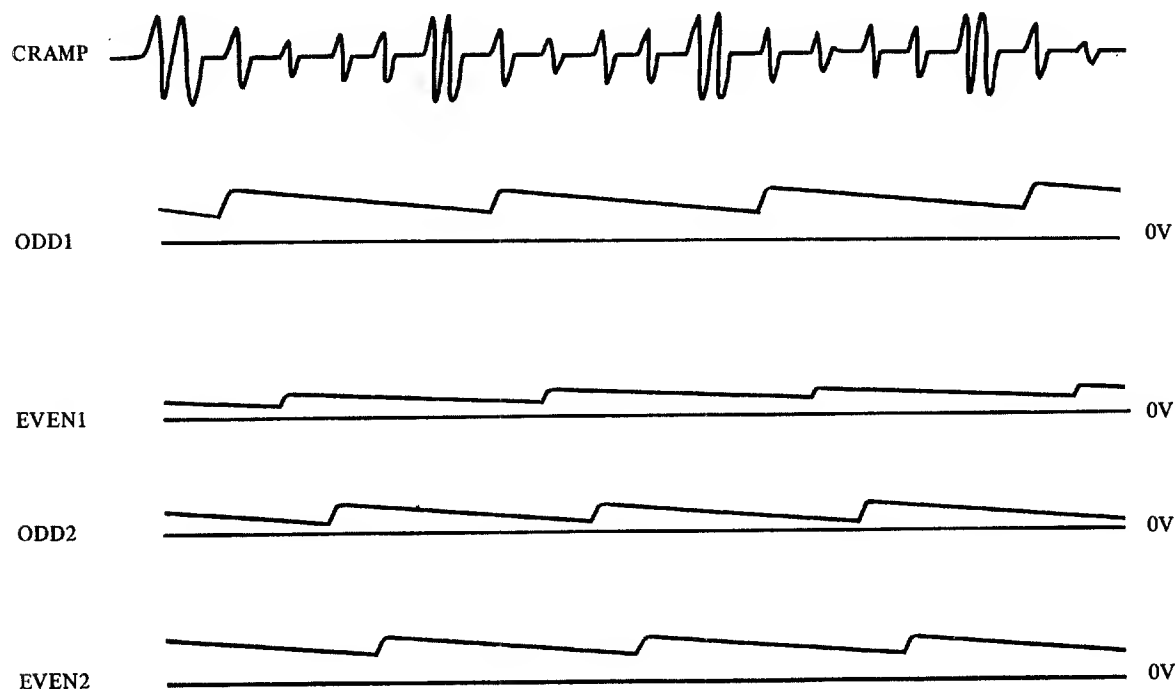


Figure 9.5-2 Peak Hold Circuit

### (3) AGC voltage generator

This circuit generates the AGC amplifier gain control signal SAGC by means of ODD1, EVEN1, ODD2, and EVEN2 which are generated by the peak hold circuit. If the output voltage of the servo head falls due to variations in the level of the signal read from the medium, the amplitude of the carrier amplifier output decreases and the output voltage of the peak hold circuit falls, lowering the SAGC voltage. When the control voltage SAGC of the AGC amplifier falls, the gain is increased to compensate for the drop in the output voltage level of the servo head. Conversely, when the output voltage rises, it is compensated for in the same manner.

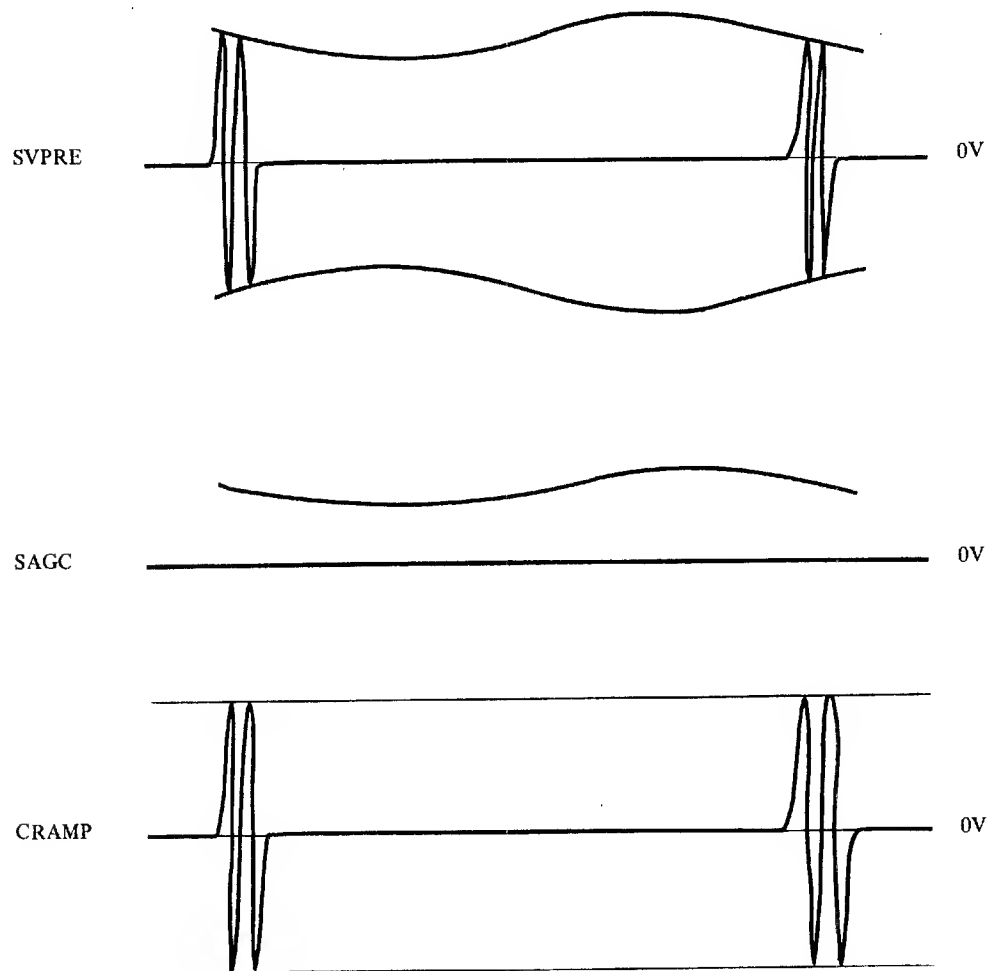


Figure 9.5-3 Function of AGC

#### (4) Sync pulse detector

The gated sync pulse signal (\*GSYNC) is generated using the signal generated by slicing the carrier amplifier signal (CRAMP). \*GSYNC is absent at the locations where the index pulses in the valid index pattern and the Guard Band patterns are written. This signal is used for the VCO and logic circuits to detect patterns.

\*GSYNC is generated by ANDing TP4 and the LTSVC signal generated by the logic circuit.

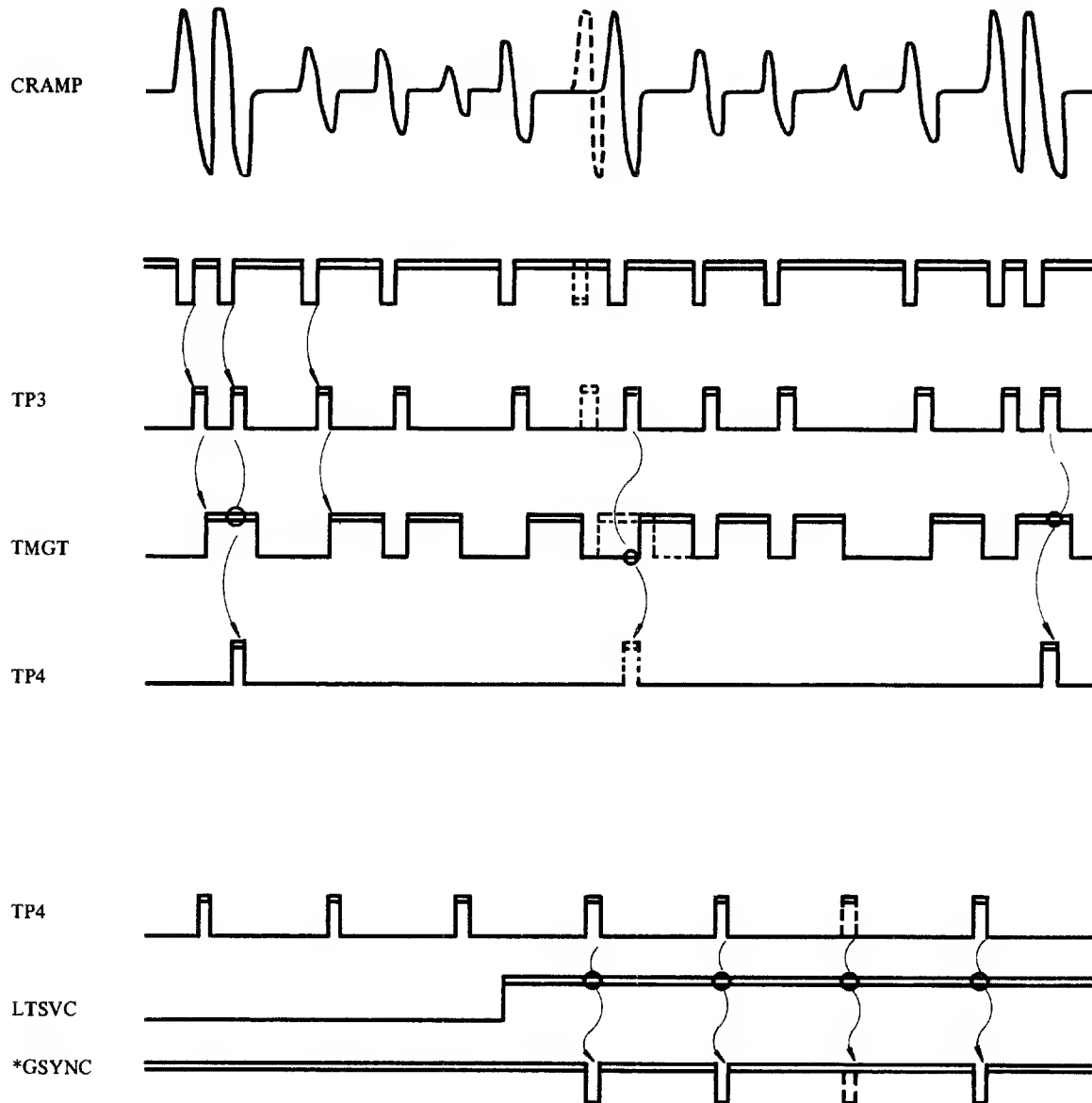


Figure 9.5-4 Detection of Sync Pulse

## (5) PLL

The PLL circuit, consisting of the phase detector, charge pump, VCO, counter, and decoder, generates gate signals used to sample ODD1, ODD2, EVEN1, and EVEN2 of the carrier amplifier. Even in the area where the index pulse is absent, the circuit generates gate signals.

### - Phase detector

This circuit detects the difference in phase between \*CT7, generated by VCO which divides \*GSYNC by 16, and \*GSYNC. It outputs \*INC or \*DEC according to a shift in phase.

### - Charge pump

The charge pump raises or lowers the PLO analog (PLOAN) voltage depending on the signal from the phase detector (\*INC/\*DEC). The output voltage of PLOAN is when the disk is rotating at the specified constant speed.

### - VCO, counter, and decoder

The VCO converts the DC voltages to the pulse oscillation frequency. The PLOAN voltage is proportional to the oscillation frequency. When the disk is rotating at the specified speed, the oscillating frequency of the VCO is 7.44 MHz, 16 times as high as the frequency of \*GSYNC. The output of the VCO is sent to the logic circuit and counted by the four-bit binary counter. The output of the counter is decoded and \*CT7 is sent to the phase detector and \*GATE1 - \*GATE4 to the peak hold circuit. \*CT15 is sent to the logic circuit to detect the valid index pattern and Guard Band Patterns.

## (6) Position amplifier

The position amplifier generates POSN by the difference between ODD1 and EVEN1, and POSQ by the difference between ODD2 and EVEN2. These two position signals are 90 degrees out of phase with each other.

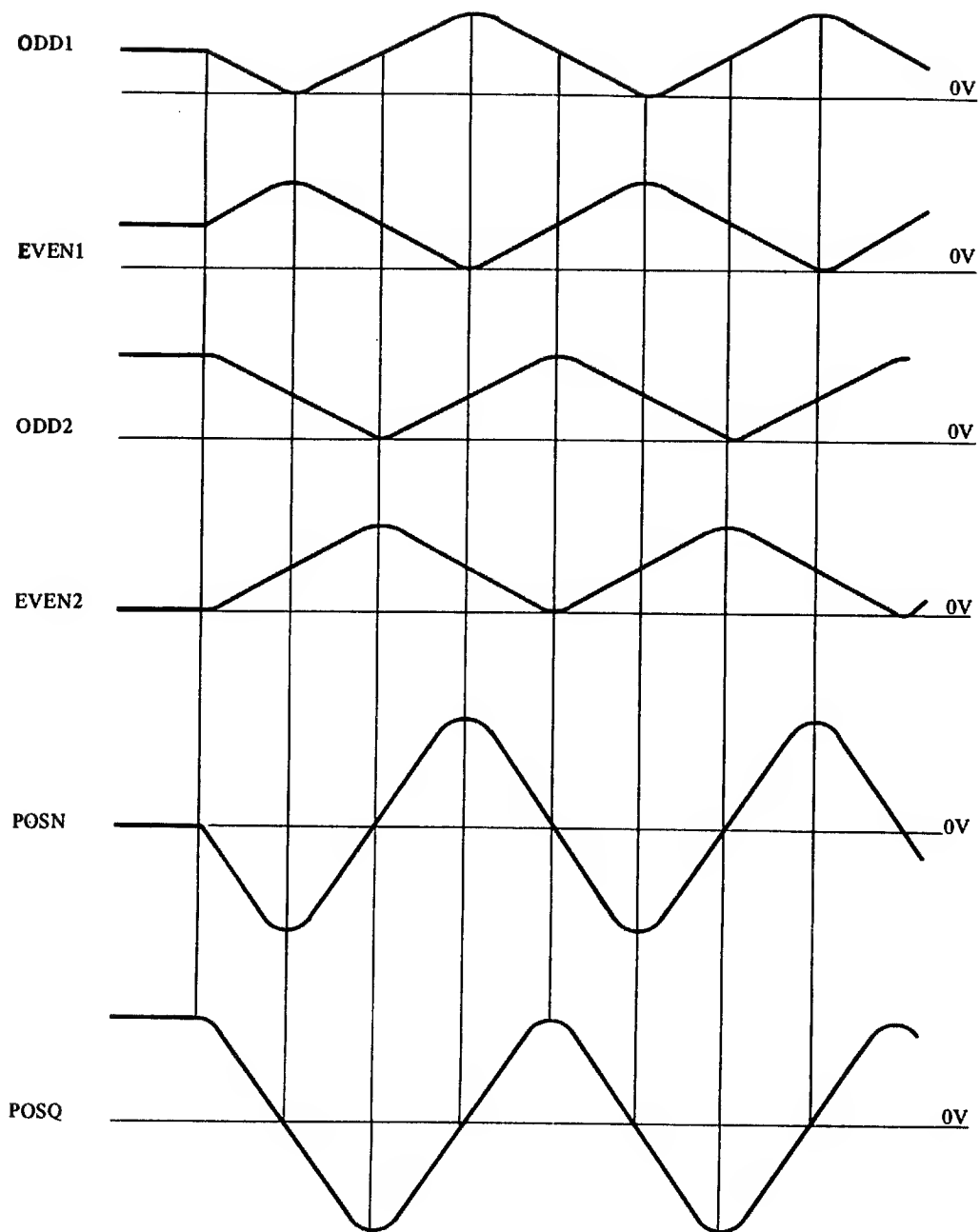


Figure 9.5-5 Position Signals

(7) State detector

The state detect circuit detects the low-order two bits of the present head position by two position signals, POSN and POSQ.

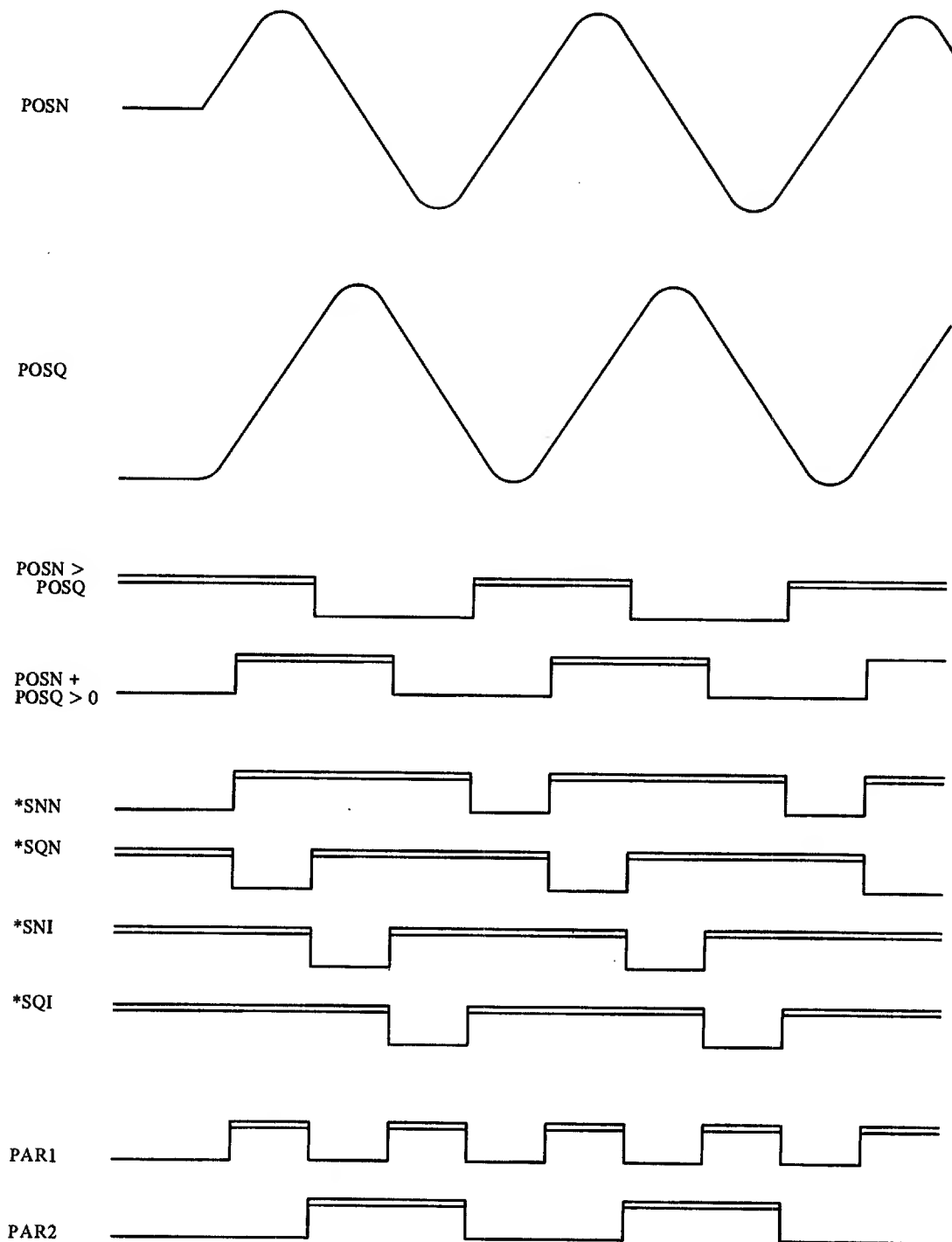


Figure 9.5-6 State of Position Signals

### (8) Smoother

The position signal (FNPOS) for fine control is generated by selecting POSN or POSQ by means of \*SNN, \*SNI, \*SQN, and \*SQI generated from the state detect circuit. Switching the polarity of FNPOS according to the carriage movement direction, the interpolation signal (SMOTH) is generated for smoothing the stair step signal from the DA converter.

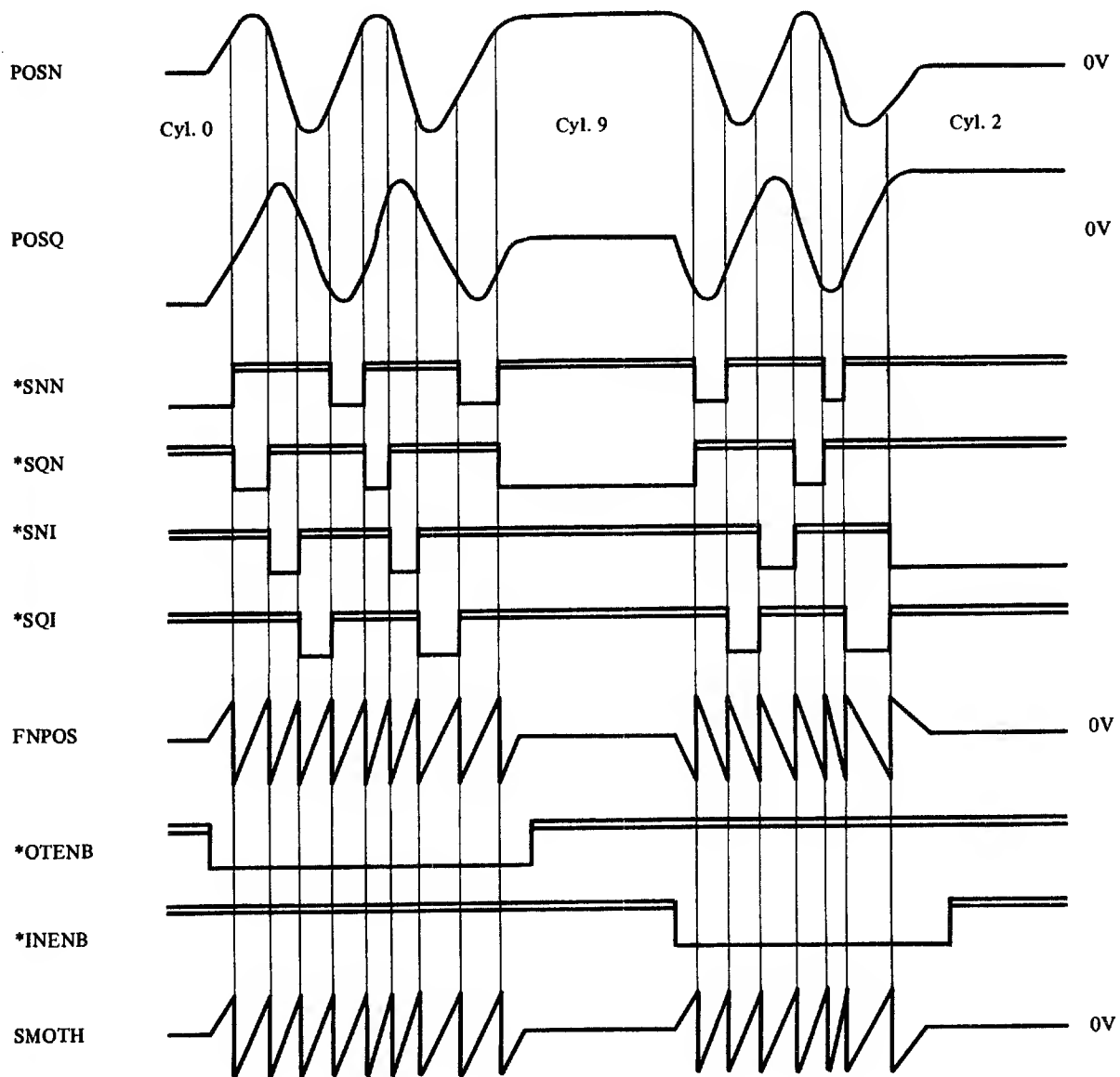


Figure 9.5-7 Output Signal of Smoother

#### (9) Clamp gate

The clamp gate holds the position signal at the specified level when the signal voltage is higher or lower than the specified level in order to extend the distance over which the head can be controlled. It generates \*EQUAL, \*PCLMP, and \*MCLMP by comparing the low-order two bits of the desired position sent from the logic circuit with the low-order two bits of the present head position sent from the state detect circuit.

#### (10) Position error circuit

The position error circuit generates the position signal (CLPOS) for position control by means of FNPOS generated from the smoother circuit and \*EQUAL, \*PCLMP, and \*MCLMP signals sent from the clamp gate circuit. It then combines CLPOS and the velocity signal (VLTY) to generate the position error signal (POSER), the error signal for fine control. At offset operation, this circuit combines the output (DACA) from the DA converter with the position signal. Figure 9.5-8 shows how the clamp circuit works when the head is moved from cylinder 0 to cylinder 9 (\*CAR1=0, \*CAR2=1).

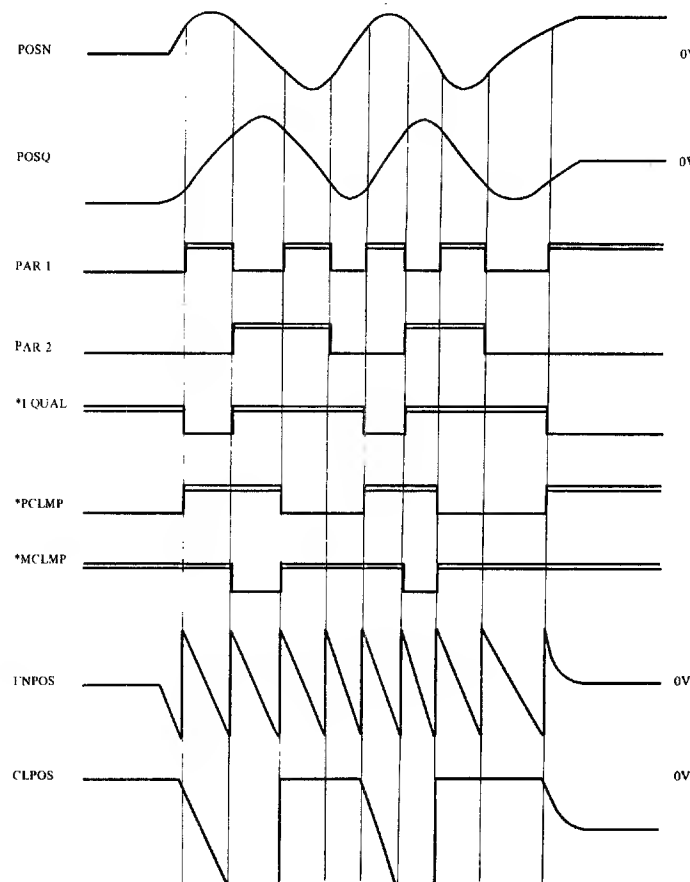


Figure 9.5-8 Clamped Position Signal



(11) Track crossing detector

The track crossing detect circuit generates the track crossing signal (TKXNG) by means of PAR1 sent from the state detect circuit and OFTRK sent from the position level detect circuit. The track crossing pulse (TKXGP) used to decrement the difference counter is generated on the rising edge of TKXNG. At rezero operation, \*GHRZ is activated to prevent TDXGP from being generated.

(12) Position level detector

The position level detect circuit generates the off-track signal (OFTRK) by slicing the position signal (POSN, POSQ) and also generates the on-track signal (\*ONTRK) by slicing the clamped position signal (CLPOS) output from the position error circuit. OFTRK is used in the circuit which generates the track crossing pulse for decrementing the difference counter in the logic circuit. \*ONTRK is used to generate switching signal (\*ENDDC) which changes the control method from the coarse control to the fine control, the signal (ENDAC) which indicates the end of carriage acceleration, and the signal (TFTMR) which indicates, after the control is switched to the fine control, that the head is positioned properly.

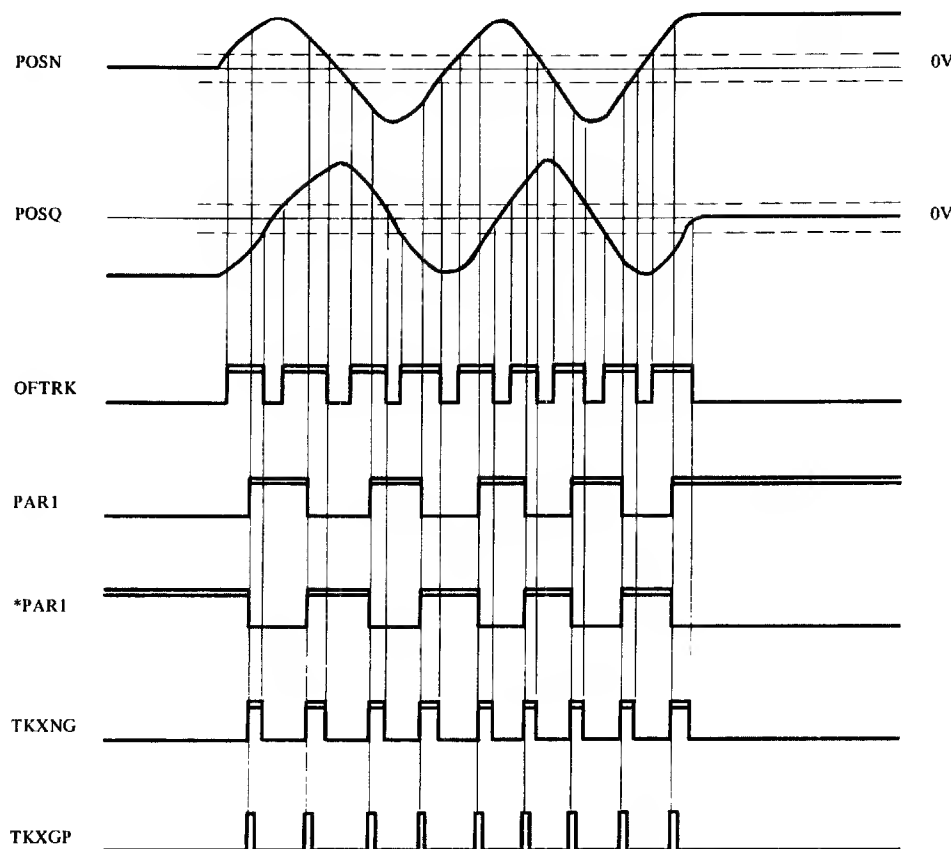


Figure 9.5-9 Position Level Detector

### (13) Target speed generator

The target speed generator, consisting of the DA converter, nonlinear circuit, and switching circuit, determines the carriage traveling speed at seek or rezero operation.

#### - DA converter

The DA converter converts the digital positional difference (held to 144 when the number of remaining cylinders is not less than 144) stored in the difference register (the number of cylinders over which the carriage is to be moved is set and is decremented whenever the track crossing pulse is detected) to the analog stair step waveform which decreases as the carriage approaches the desired cylinder. The DA converter is also used in converting the offset amount (3-bit digital amount) to the corresponding analog voltage at offset operation.

#### - Non-linear circuit

The nonlinear circuit combines the stair step signal sent from the DA converter with the signal sent from the smoother to smooth the waveform and, at the same time, generates the deceleration curve which is optimum from viewpoints of decelerating current and the access time. In addition, it applies the output from the charge-discharge circuit, which is controlled by the acceleration signal (ACCEL), to prevent excessive accelerating force from being applied to the carriage.

#### - Switching circuit

The switching circuit selects the target velocity for seek operation, and rezero operation generated based on the reference voltage by means of various logic signals generated by the servo logic circuit.

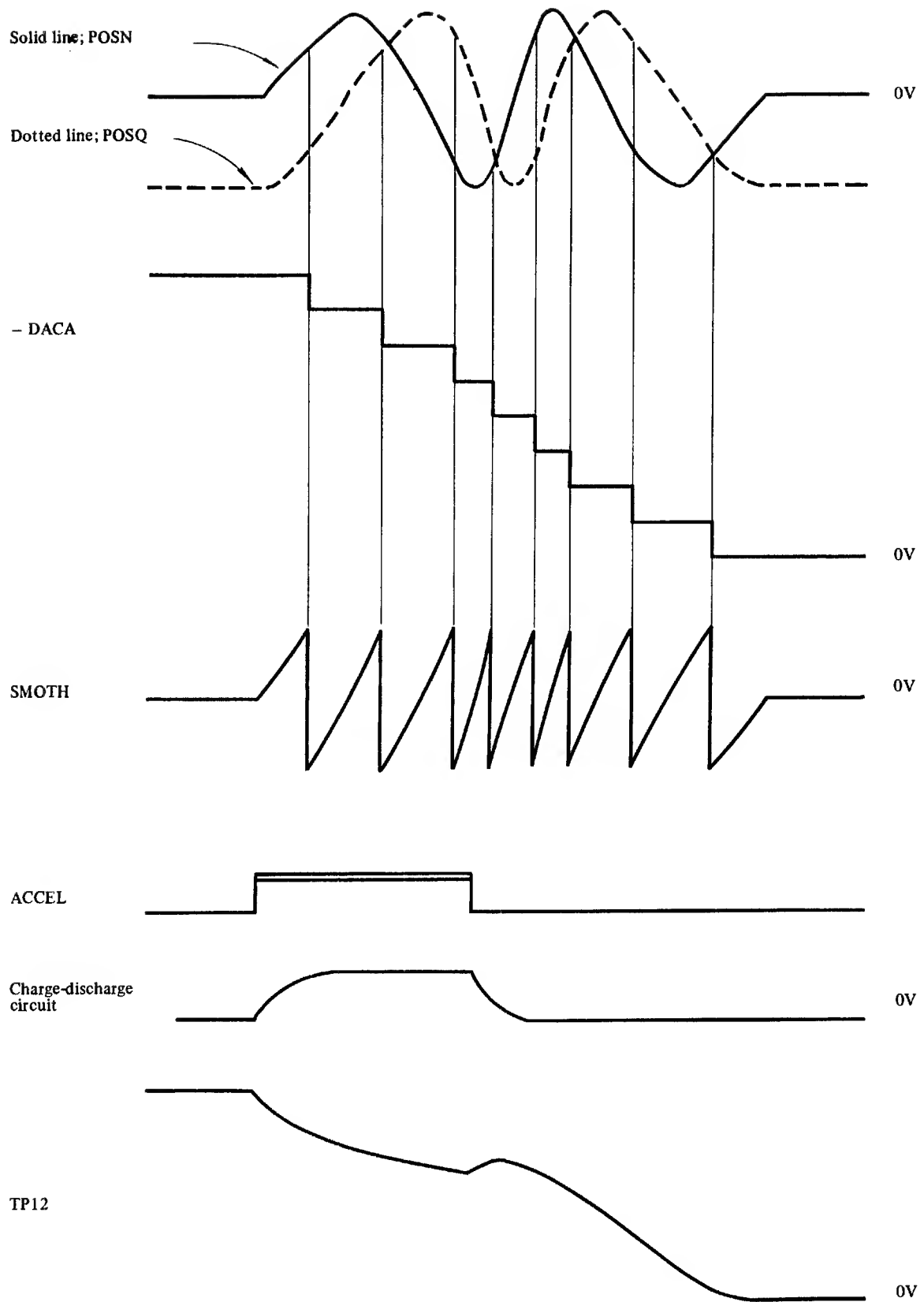


Figure 9.5-10 Target Speed

Figure 9.5-11 is the timing chart of the signals at the rezero operation:

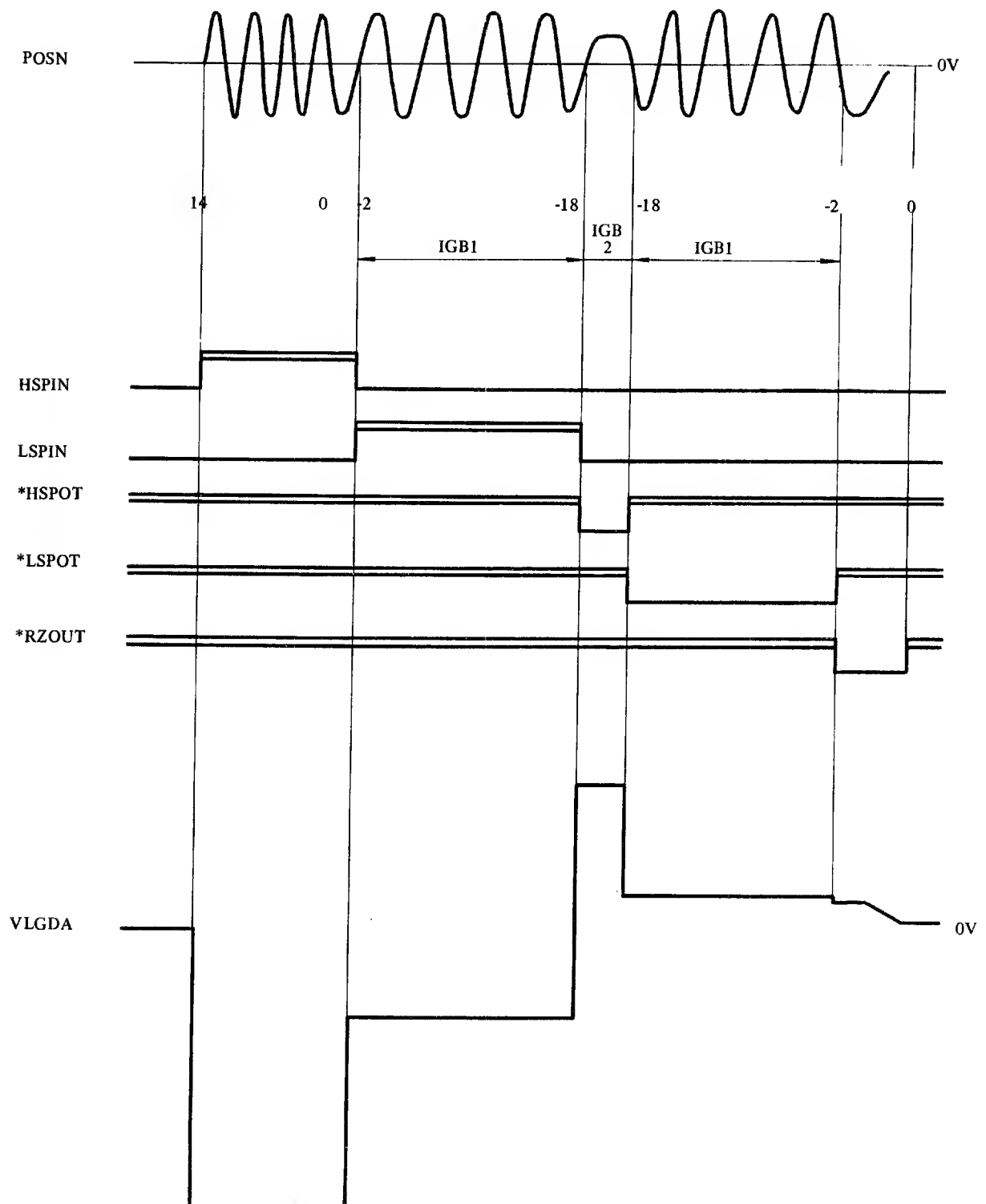


Figure 9.5-11 Signals in Rezero Operation

(14) Velocity detector

The velocity detect circuit generates the velocity signal by composing the differentiated value of the position signal (POSN and POSQ) for the linear portion with the integrated value of the coil current (CSNSE) in the rotary actuator. The output of the state detect circuit is used to select the linear portion of the position signal.

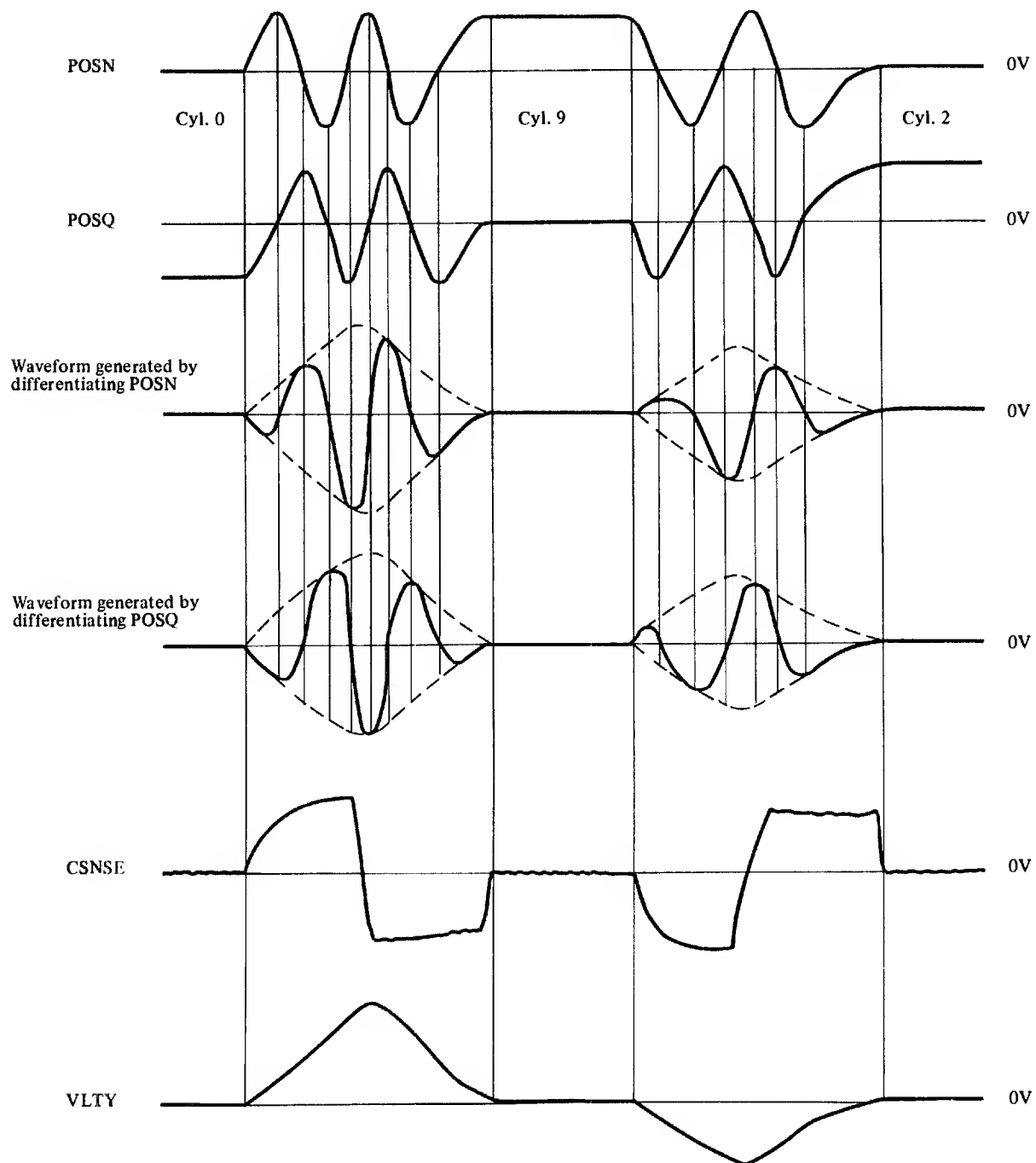


Figure 9.5-12 Velocity

#### (15) Velocity level detector

The velocity level detect circuit slices the velocity signal (VLTY) and sends CAPVL and \*VG20I signal to the logic circuit. CAPVL, which indicates the carriage velocity is lower than the specified value, is used to prevent the rezero operation from being started while the carriage is being moved at high speed and also used to provide switching moment from coarse control to fine control. \*VG20I, which indicates the carriage velocity is too high during the rezero operation, is used to monitor the access mechanism.

#### (16) Velocity error circuit

The velocity error circuit generates the velocity error signal (VLERR) which indicates a difference between the target velocity signal VLGDA and the actual velocity signal VLTY. It also generates, by slicing VLERR, the end accelerate signal (ENDAC) which indicates the end of acceleration.

#### (17) End decelerate detector

The end decelerate detect circuit generates the end decelerate signal (\*ENDDC) which indicates switching of the control mode from the coarse control to the fine control. That is, the circuit generates \*ENDDC after the specified time has elapsed from the moment \*ONTRK goes low and \*EQUAL is low. At this time, CAPVL is used to indicate that the velocity is lower than the specified velocity.

#### (18) Timer

The timer is used to generate the track following timer signal (TFTMR) which informs the logic circuit that the access operation has been completed normally after the specified time period from the moment the control mode had been switched to the fine control or, it sends the access timeout signal (ACTMO), which indicates that the operation has not been completed within the specified time period after the start of movement. It also provides the time setting signal (M3M, \*OFINT) to be used during an offset operation.

#### (19) Reference voltage generator

The reference voltage generator generates -4V and +6V reference DC voltages to be supplied to the head IC on the servo head assembly. They are also used as reference voltages for various level detect circuits and the desired velocity level during a rezero operation.

## (20) Servo logic

The servo logic generates various signals used in coarse control and fine control based on the control logic signals sent from the logic circuit.

## (21) Power amplifier interface

This is the interface between the power amplifier for driving the rotary actuator and spindle motor and the servo circuit. When the coarse control operation is performed, the interface selects VLERR by means of \*CORSE. When the fine control is performed, the interface selects POSER by means of \*GLNMD. One of these signal is sent to the power amplifier as the power amplifier drive signal (PADRV). When the rezero operation is performed, the amplifier gain of PADRV is reduced to avoid the excessive acceleration force to be applied to the carriage and the head. In addition, a DC bias circuit is provided to prevent the head from moving away from the CSS area when the spindle motor rotation is lower than the specified rotational speed (3,961 rpm  $\pm$  2%). The interface for the power amplifier of the rotary actuator includes the current sense signal (CSNSE) which is proportional to the current in the drive coil and the overcurrent signal (OVCRT) which indicates an excessive current flows. The interface for the power amplifier of the spindle motor includes the spindle start signal (\*SPSTT) which indicates the start/stop of the motor, the speed alarm signal (SPALM) which indicates that the rotational speed is not in the range of 3961 rpm  $\pm$  2%, and the hall alarm signal (HALM) which indicates an abnormal condition of the hall-effect element used for monitoring the spindle motor rotation.

## (22) Power amplifier for rotary actuator

This amplifier provides drive coil current proportional to PADRV sent through the power amplifier interface and sends CSNSE to the servo circuit upon detection of coil current. In addition, it sets OVCRT high to indicate an abnormal condition when current of 5A or more flows for 0.7 seconds or longer.

## (23) Power amplifier for spindle motor

This amplifier controls the spindle motor so that it rotates at the specified speed (3961 rpm) when the spindle start signal (\*SPSTT) is "0". The rotational speed is checked by the output of three hall-effect elements which are equipped in the motor. The rotational speed is compared with the specified speed each time the disk rotates; if the speed is lower than 3961 rpm, the amplifier provides current and, if the speed is higher than 3961 rpm, current does not flow, allowing

the disks to be rotated by the force of inertia. The speed alarm signal (SPALM) is changed from "1" to "0" when the rotational speed comes up to 3961 rpm, and changed to "1" again when the rotational speed is not within the specified range. The rotational speed monitor circuit is reset when the disk is restarted. The following diagram shows the outputs of the hall-effect elements.

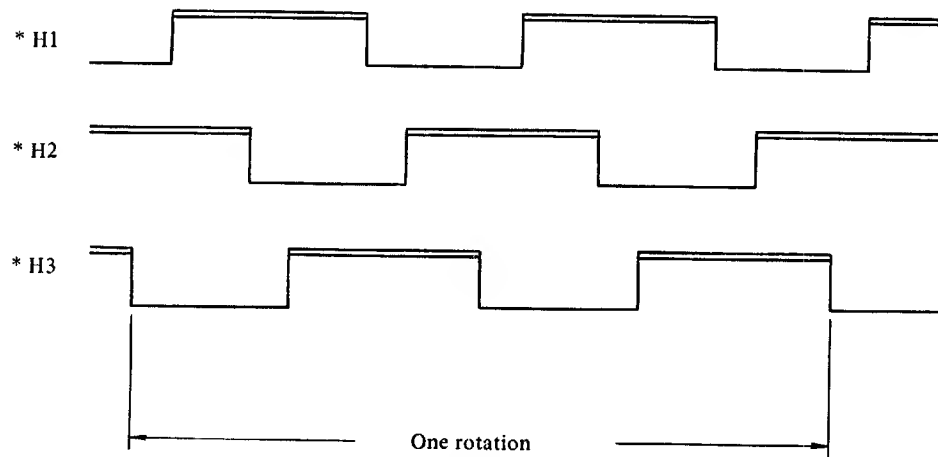


Figure 9.5-13 Outputs of Hall-Effect Elements





## CHAPTER 10 READ WRITE CIRCUIT

### 10.1 WRITE CIRCUIT

When a write command is issued from the controller after head selection, Write Data and Write Clock signals are sent to the drive. Through the MFM modulator and write compensation circuit, Write Data in NRZ code is converted into WDATA in MFM code.

The block diagram of Read/Write circuit is shown in Figure 10.1-1, and the block diagram of circuits in the DE is shown in Figure 10.1-2.

#### (1) Head Select - Movable Heads

Movable heads are selected by Head Address Register outputs (\*HAR1 through \*HAR16). \*HAR4, \*HAR8 and \*HAR16 are also decoded and used as Chip Select signals (\*CHP0 ~ \*CHP4).

One of the 5 head ICs on the head arm assemblies is selected according to the Chip Select signals.

The low-order two bits of Head Address Register (\*HAR1 and \*HAR2) are converted from TTL to ECL level and used as Head Select signals to select one of the 4 heads.

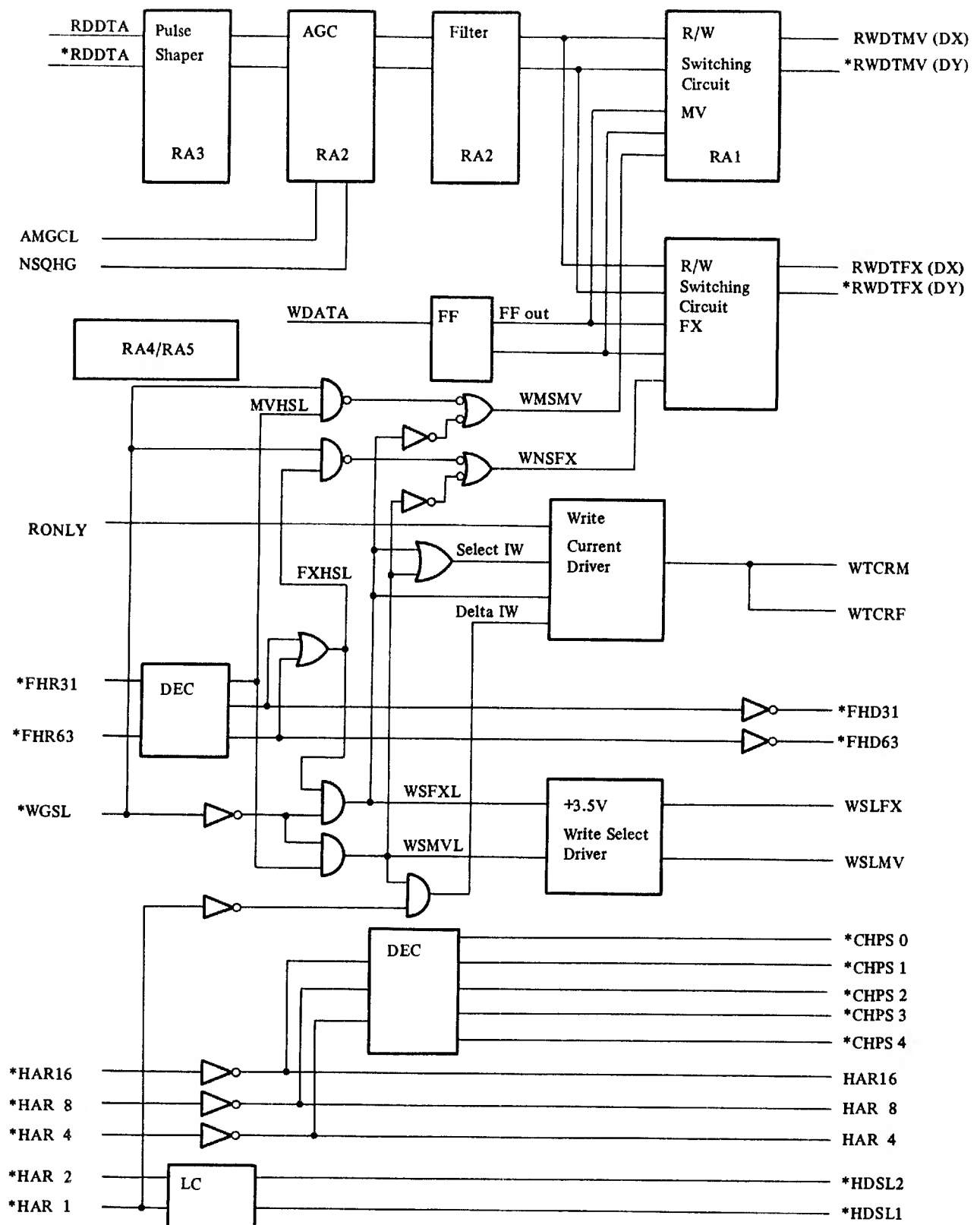


Fig. 10.1-1 Read/Write Circuit Block Diagram

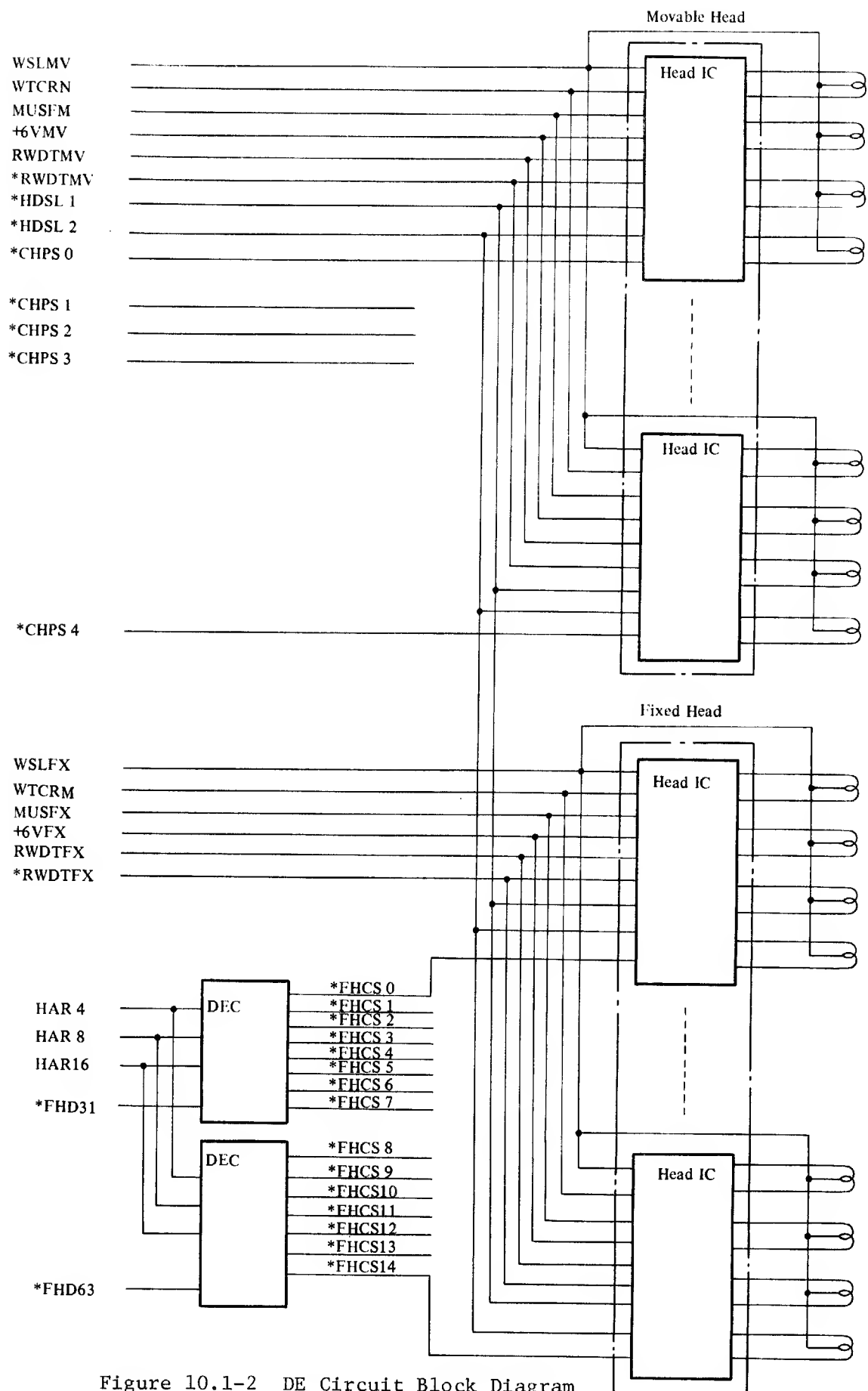


Figure 10.1-2 DE Circuit Block Diagram

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## (2) Head Select - Fixed Heads

Fixed heads are selected by Fixed Head Register outputs (\*FHR31 and \*FHR63) and Head Address Register outputs (\*HAR4, \*HAR8 and \*HAR16). \*HAR4, \*HAR8 and \*HAR16 are inverted and, in conjunction with \*FHR31 and \*FHR63, are sent to two decoders in the DE. These decoders provide Fixed Head Chip Select signals (\*FHCS0 through \*FHCS14) to select one of the 15 fixed head ICs which are mounted on the PCB in the DE. \*HDSL1 and \*HDSL2 then select one of the four cores in the fixed head.

## (3) Write Select

Write Select Fixed Head (WSLFX) and Write Select Movable Head (WSLMV) signals are constant-voltage +3.5 volts in the active state and are connected to the head center taps during a write operation. Write Gate Select (\*WGSL) is low during a write operation, enabling Write Select Movable Head (\*WSLMV) and Write Select Fixed Head (\*WSLFX). Depending on the mode selected (fixed or movable), the +3.5 volt Write Select drive (WSLFX or WSLMV) is sent to the respective heads in the DE.

## (4) Write Current Source

The write current driver is a constant-current power source which supplies write current to the head. The write current varies depending on the signals Select IW, \*WSLFX and Delta IW as follows:

|                                                   |       |
|---------------------------------------------------|-------|
| Odd number movable head:<br>(Inner movable head)  | 20 mA |
| Even number movable head:<br>(Outer movable head) | 25 mA |
| Fixed head 0 ~ Fixed head 31:                     | 40 mA |
| Fixed head 32 ~ Fixed head 59:                    | 45 mA |

The write current driver is disabled by Read Only signal (RONLY).

## (5) Write Data

Write data (WDATA) is sent out from the MFM modulator and the write compensation circuit in the VF0. The flip-flop is clocked by the positive-going edge of the WDATA signal, and its output is sent to two (bidirectional) Read/Write switching circuit. The write data is switched to the DX, DY inputs to the DE if either \*WSLFX (fixed) or \*WSLMV (movable) is active.

The DX, DY signals from the respective switching circuit drives the Head IC as Write Data. A timing chart of the Read/Write flip-flop circuit is shown in Figure 10.1-3.

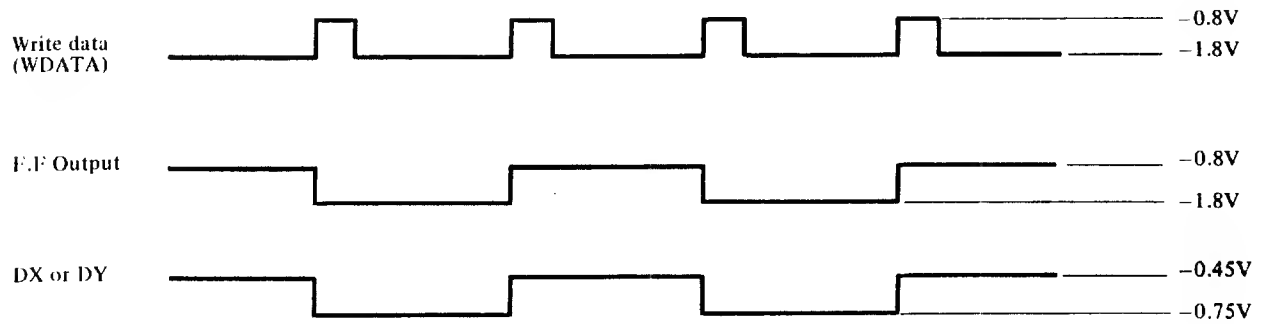


Fig. 10.1-3 Read/Write Flip-Flop Timing Chart

## 10.2 READ CIRCUIT

When a read command (Tag 3, Bus 1) is issued by the controller, Read Gate signal becomes active and the read operation is initiated. The Read/Write circuit block diagram is shown in Figure 10.1-1.

### (1) Read/Write Switching Circuit

The read circuit is enabled anytime Write Mode Select Movable Head (WMSMV) and Write Mode Select Fixed Head (WMSFX) signals are inactive. The DX, DY signals from the Head IC output are applied to the Read/Write switching circuit IC (MB4316), amplified and sent to a low pass filter circuit. The block diagram is shown in Figure 10.2-1.

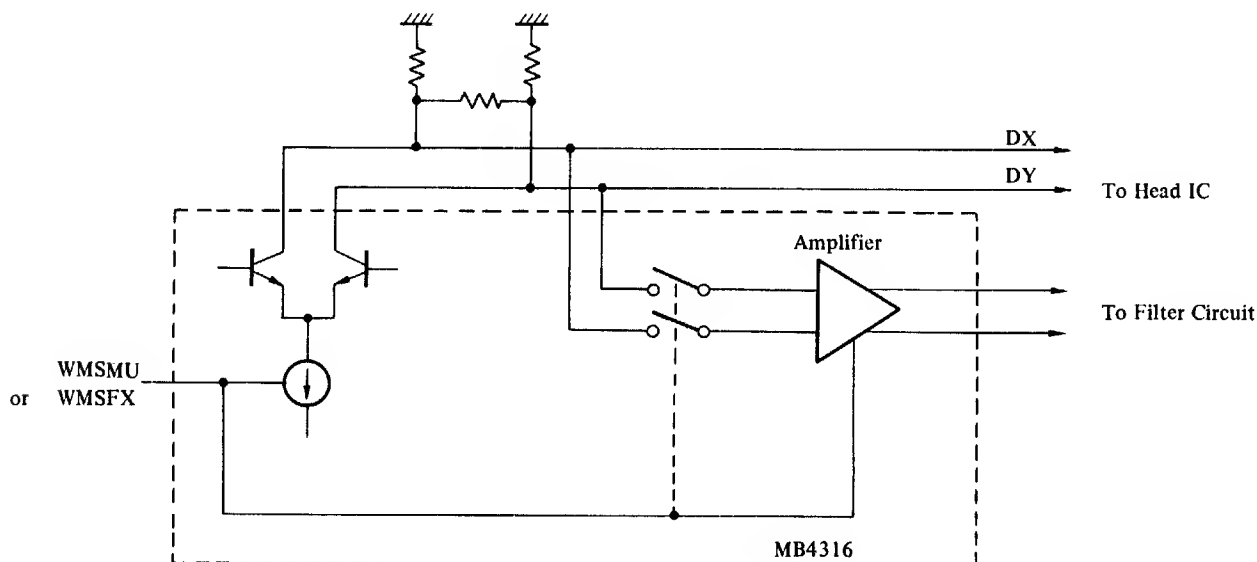


Fig. 10.2-1 Read Write Switching Circuit

### (2) Low Pass Filter Circuit (LPF)

The purpose of the low pass filter is to attenuate high-frequency noise. The filter is a Butterworth, with a cut-off frequency of approximately 14 MHz.

### (3) AGC Circuit

The AGC loop consists of an AGC amplifier IC (MB4303) and a level sensor IC (MB4311). The LPF output signal is applied to the AGC amplifier, and sent to the level sensor IC. Here, it is further amplified (about 10 times) before being applied to the level sensor and charge pump (LSCP) circuit and out to a pulse shaper circuit.

The LSCP circuit compares the peak of AC voltage of the AGC output signal with the DC reference voltage 1 (RFV1) and 2 (RFV2). If the voltage of the AGC output signal is lower than the voltage of the RFV1 signal, the LSCP discharges the capacitor 1 (C1) and the voltage VAGC decreases. The decreasing VAGC causes the AGC Amplifier to increase amplitude (gain). The AGC output signal is amplified about 2.6 volts peak to peak. Figure 10.2-2 is a block diagram of the AGC loop circuit.





When Write Gate Select signal (\*WGSL) is deactivated, the read circuit is activated. However, a read transient caused by the DC unbalance of the read pre-amplifier will occur. Therefore, Not Squelch Gate signal (NSQHG) is enabled about 2  $\mu$ sec after the Write Gate Select signal (\*WGSL) goes high.

The NSQHG signal suppresses this read transient. The AGC squelch function is shown in Figure 10.2-3.

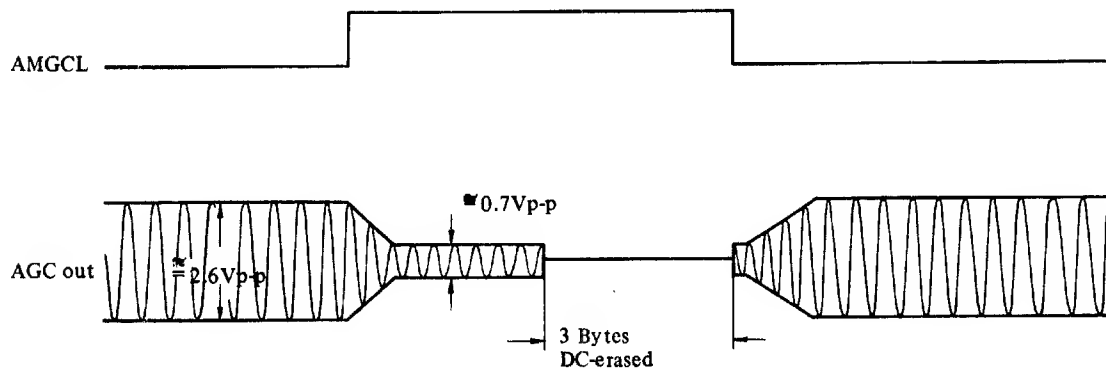


Fig. 10.2-4 AM Search Function

In the variable sector format mode, the address mark (AM), which is a three-bytes DC-erased area, is used for detecting the beginning of a sector. When the controller issues an AM read command, AM Gate Control signal (AMGCL) goes high and decreases the DC voltage of RFV1.

This suppresses the gain of the AGC circuit to avoid false AM detection caused by external noise or media noise in the DC-erased area.

The AM search function is shown in Figure 10.2-4.

#### (4) Pulse Shaper Circuit (Analog-to-digital converter)

The analog-to-digital converter or pulse shaper has two fundamental circuit; a differentiator which differentiates the AGC output signal and then converts the peaks (flux transition) into zero-crossing signals; and, an integrator which AC-slices the AGC output signal (floating slice) and then generates data window pulse signals.

The block diagram is shown in Figure 10.2-5 and the timing chart in Figure 10.2-6.

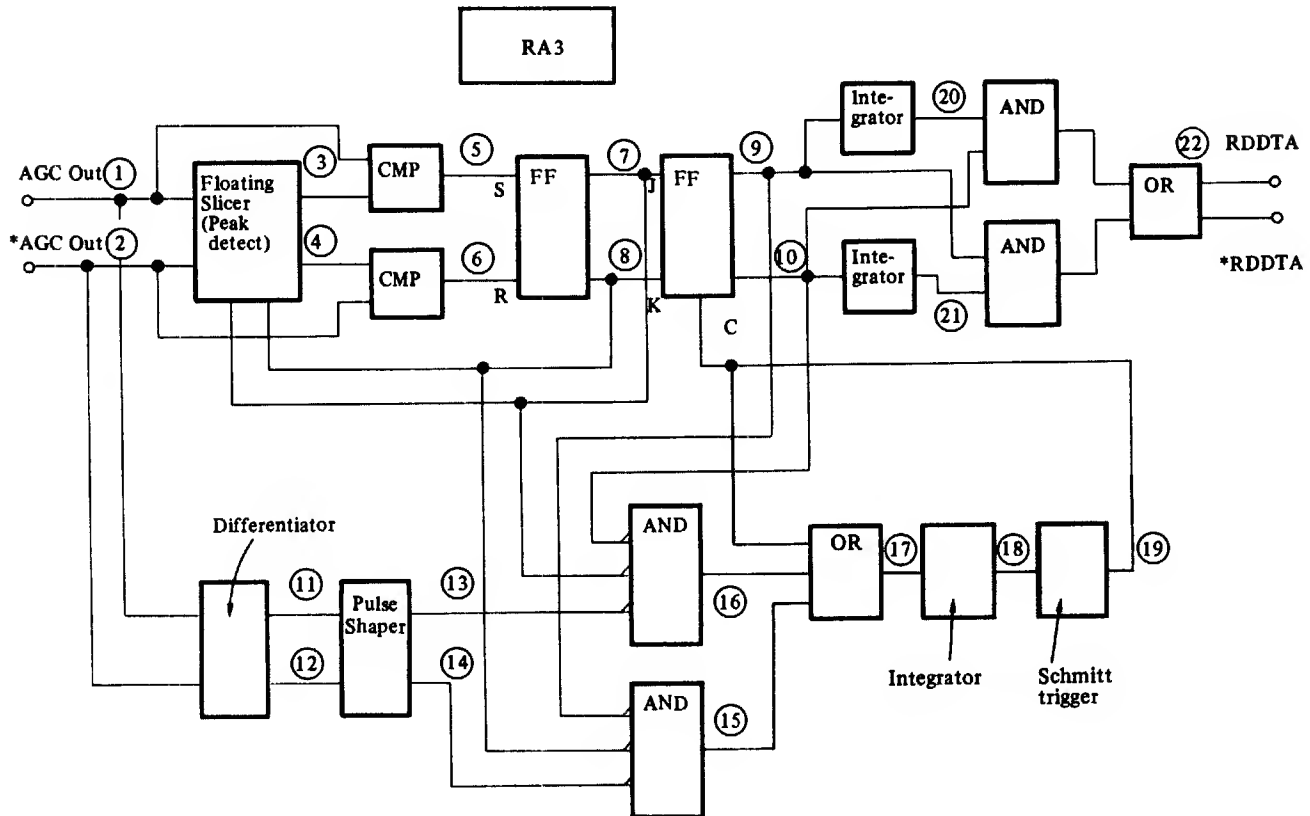


Fig. 10.2-5 Pulse Shaper Circuit Block Diagram

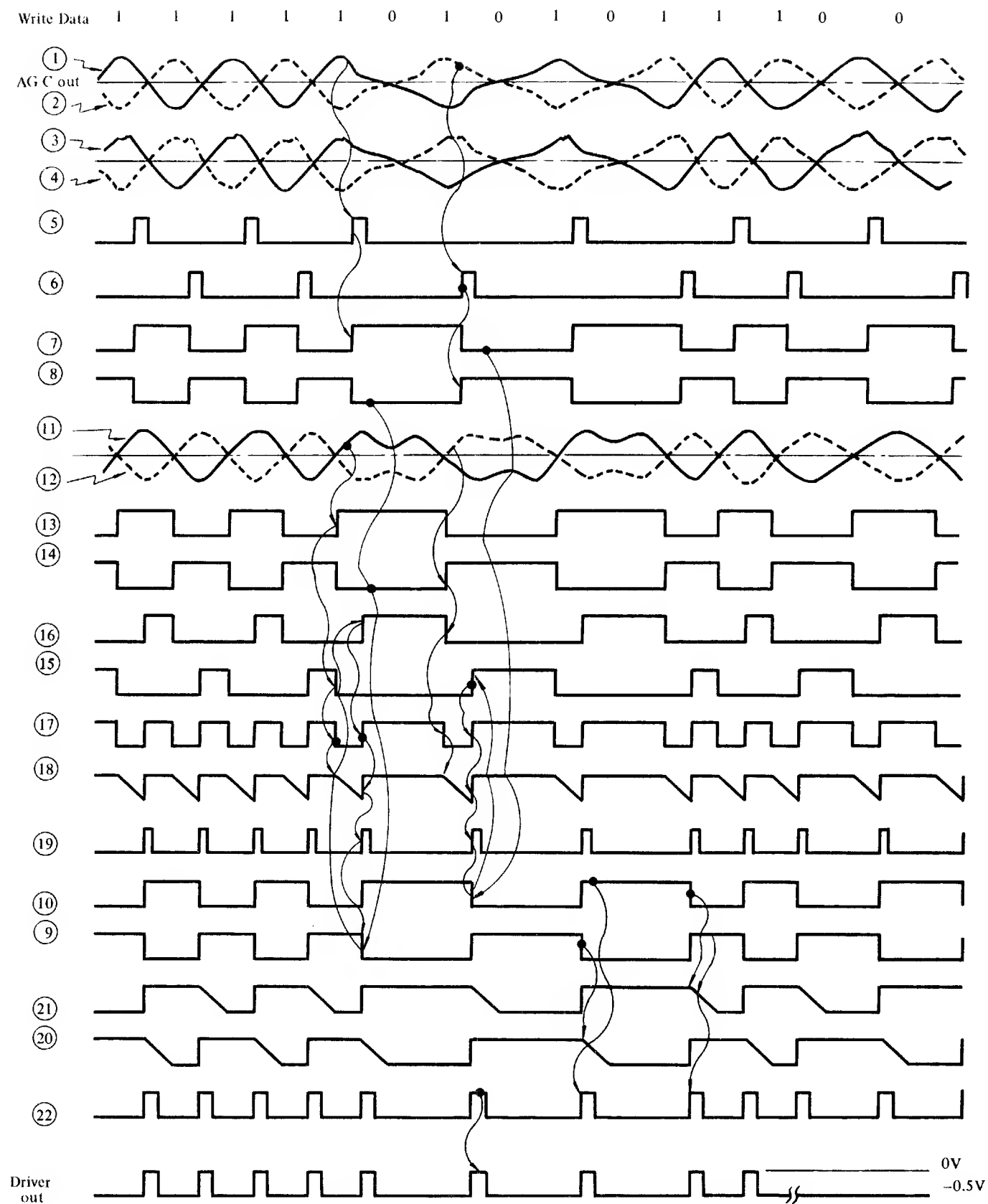


Fig. 10.2-6 Pulse Shaper Circuit Timing Chart

### 10.3 ERROR DETECTING CIRCUIT

The Read/Write circuit has the following error detecting circuits:

#### (1) Head Short Check

This circuit detects any abnormal current flowing in Write Select Line during Write operations. The block diagram is shown in Figure 10.3-1.

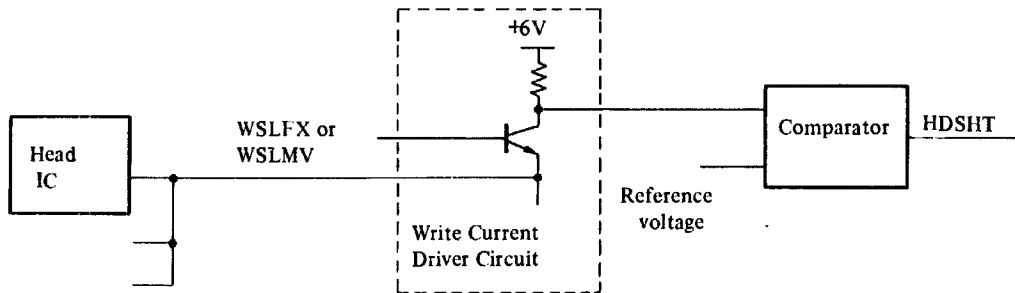


Fig. 10.3-1 Head Short Check Block Diagram

#### (2) Multi Head Check

This circuit detects that two or more head ICs have been selected. The block diagram is shown in Figure 10.3-2.

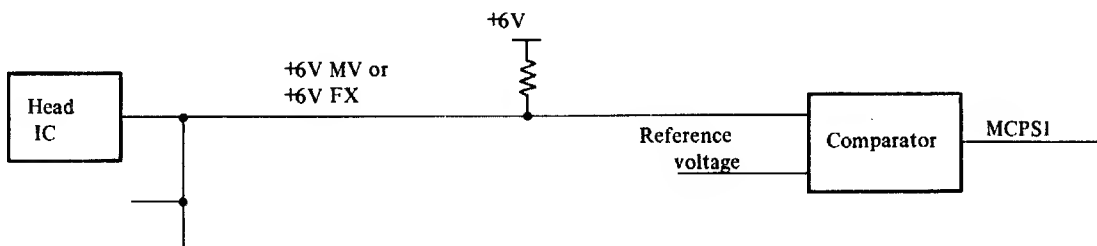


Fig. 10.3-2 Multi Head Check Block Diagram

### (3) Delta I Write Check

This circuit checks for normal write-current supplied to the Head IC and Head. The write-current source contains three circuits; Main IW circuit, Delta IW1 circuit and Delta IW2 circuit.

If an even number movable head is selected, for example, Select I write (SLIW) and Gated I Write 1 (GDIW1) signals are enabled. Then Main IW circuit and Delta IW1 circuit are activated and supply about 25 mA of write-current.

But, in this case, if the Delta IW1 circuit is not active, the detector senses this and Delta I Write Check signal goes high.

The block diagram is shown in Figure 10.3-3.

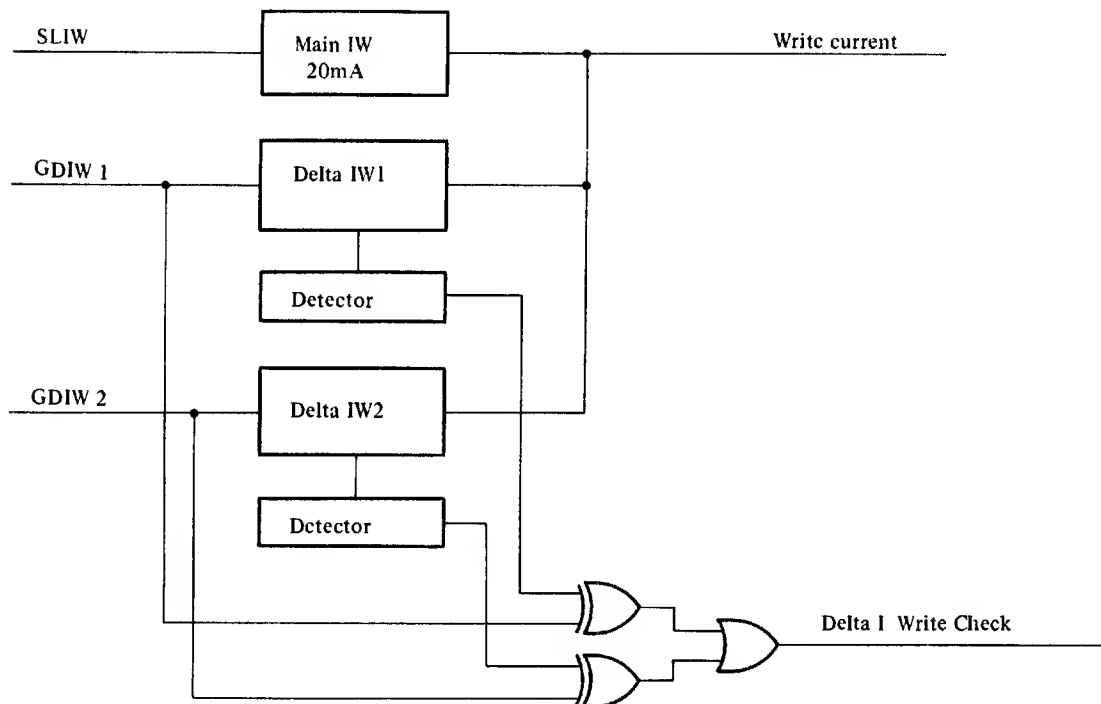


Fig. 10.3-3 Delta I Write Check Block Diagram

#### (4) Write Transition Check

During a write operation, the write-current in a data head coil flows in alternate directions according to the write data pulse train.

If this write-current transition is not performed, the Mars Unsafe Fixed Head or Movable Head (MUSFX, MUSMV) signal goes high and the FF will set the Write Transition Check signal to high about 12 bytes after the leading edge of the Write Gate.

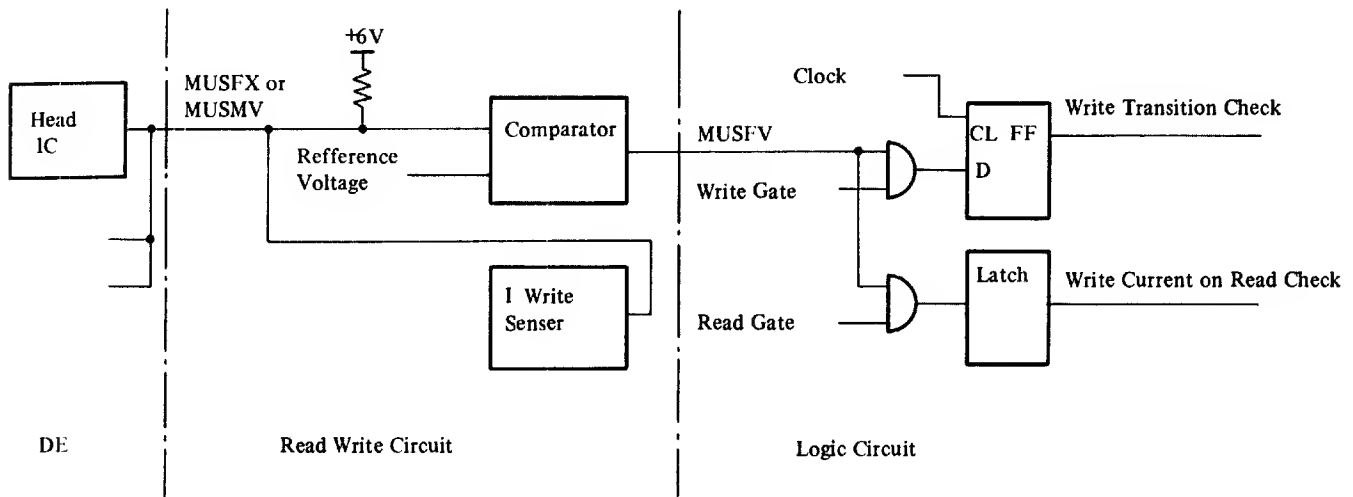


Fig. 10.3-4 Write Transition Check and Write Current on Read Check Block Diagram

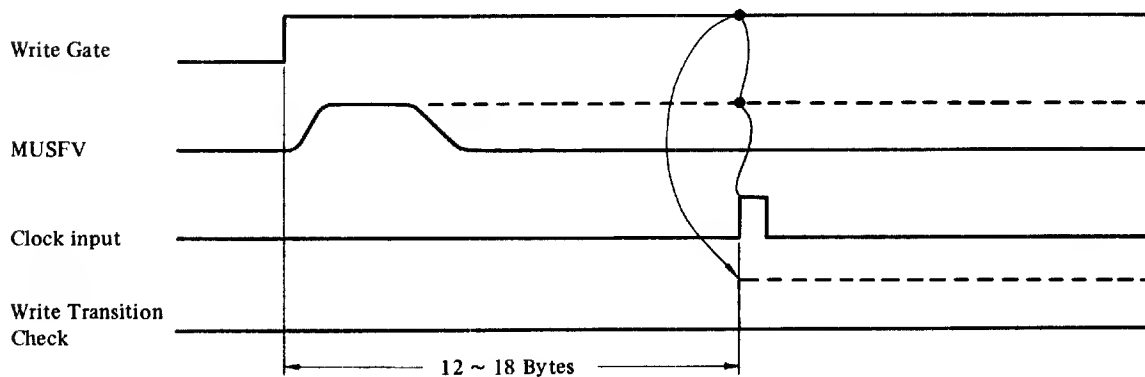


Fig. 10.3-5 Write Transition Check Timing Chart

The write transition check block diagram is shown in Figure 10.3-4 and timing chart in Figure 10.3-5.

(5) Write Current on Read Check

This circuit detects any write current during a not write operation. The block diagram is shown in Figure 10.3-4.



## 10.4 DE INTERFACE

The interfaces between the DE (Disk Enclosure) and the printed circuit board are shown in Table 10.4-1. The DE circuit block diagram is shown in Figure 10.1-2.

Table 10.4-1 DE Interface

| Signal Name |    | Level      |            | DE Connector | Pin No.  |
|-------------|----|------------|------------|--------------|----------|
|             |    | Select     | Non-Select |              |          |
| *CHPS       | 0  | 0 ~ +0.4V  | ≅6V        | CND          | 03       |
| "           | 1  | "          | "          | "            | 05       |
| "           | 2  | "          | "          | "            | 07       |
| "           | 3  | "          | "          | "            | 09       |
| "           | 4  | "          | "          | "            | 11       |
| *HDSL       | 1  | ECL Low    | ECL High   | "            | 36       |
| "           | 2  | "          | "          | "            | 38       |
| HAR         | 4  | "          | "          | "            | 17       |
| "           | 8  | "          | "          | "            | 15       |
| "           | 16 | "          | "          | "            | 13       |
| *FHD        | 31 | "          | "          | "            | 23       |
| "           | 63 | "          | "          | "            | 21       |
| *FHFB       |    | 0V         | Open       | "            | 01       |
| WTCRM       |    | Special    | Special    | CNE          | 09       |
| WTCRF       |    | "          | "          | "            | 10       |
| WSLMV       |    | +3.5V 0.3V | 0V 0.1V    | CND          | 28       |
| WSLFX       |    | "          | "          | "            | 30       |
| MUSFM       |    | Special    | Special    | "            | 32       |
| MUSFX       |    | "          | "          | "            | 34       |
| +6VMV       |    | *          | *          | "            | 25       |
| +6VFX       |    | *          | *          | "            | 26       |
| +5VFX       |    | *          | *          | CNE          | 19       |
| -4VDE       |    | *          | *          | "            | 13,14,15 |
| RWDTMV      |    | Special    | Special    | "            | 06       |
| *RWDTMV     |    | "          | "          | "            | 05       |
| RWDTFX      |    | "          | "          | "            | 01       |
| *RWDTFX     |    | "          | "          | "            | 02       |

## Description of signals

### (1) \*CHIP SEL 0 ~ 4

CHIP SEL is the signal which selects one of the 5 movable head ICs. Two or more movable head ICs must not be selected simultaneously. Simultaneously selecting two or more movable head ICs causes Multi Head error.

### (2) \*HDSL 1 and 2

Each HEAD IC has 4 read/write channels. These signals are used to select one of the four heads connected to each channel.

### (3) \*HAR 4, 8, and 16

These signals are used to select a fixed head. These signals are used in conjunction with the \*FHD31 and \*FHD63 signals to generate the 15 Chip Select signals in the fixed head block.

### (4) \*FHD31 and 63

See the above.

### (5) \*FHFB

This signal is clamped to 0 V when the Fixed Head block is installed in the DE.

### (6) WTCRM, WTCRF

This is the line through which the write current is supplied to the head.

### (7) WSLMV, WSLFX

These signals are the write gate signals for the head IC and head center tap voltage.

### (8) MUSFM, MUSFX

These signals are used to detect the transient during write operations. These signals also detect the fact that Write current is flowing during read operations.

(9) +6VMV, +6VFX

These are the DC voltages to be supplied to the head IC. If no head IC is selected, there is no load current. If a head IC is selected, the load current for one head IC is constant. When the load current exceeds the specified value for one head IC, Multi Head Check occurs.

(10) (\*)RWDTMV, (\*)RWDTFX

The write data is sent to DE during a write operation, and the read data is sent from the DE during a read operation.

The VFO circuit consists of Switching Gate, Time-margin Measurement Monostable multivibrator (TMM), Reference Monostable multivibrator, Latch, Phase Comparator and Charge Pump, Low Pass Filter, Voltage Controlled Oscillator, MFM Demodulator, MFM Modulator and Write Compensator, as shown in Figure 11.1-1.

### 11.1 MFM MODULATOR AND WRITE COMPENSATION CIRCUIT

When the bit density (BPI) is high on a disk surface, and a read operation is performed, peak shift phenomenon appears. A bit span tends to widen the narrow part of the bit spacing because of mutual magnetic interference of the bits.

When such a phenomenon appears, reading of the data will deviate from the correct bit spacing, causing data errors. The write compensation circuit measures the peak shift direction and amount that will occur during the read operation, and generates pre-shifted write data in the opposite direction. Figure 11.1-2 shows the block diagram of the MFM Modulator and Write Compensation Circuit, and Figure 11.1-3 shows the timing chart.

The NRZ Write Data (WRDT) sent from the controller is clocked by the positive-going edge of the WTCL, and then the WTDI is synchronized with the internal VFO write clock by a Sync Decision Window circuit at the negative-going edge of the Write Gate Select (\*WGSL).

The NRZ write data, synchronized with the internal write clock, is applied to a four-bit shift register. Each output of the four-bit shift register is applied to a MFM Modulator and Write Compensation circuit, and then converted into a modified frequency modulated and pre-shifted data pulse train, according to the truth table as shown in Table 11.1-1.

The pre-shift timing of write compensation is defined by 2F Early 1 (2FE1), 2F Early 2 (2FE2), 2F On-time (2FOT) and 2F Late (2FLT) clock signals.

Table 11.1-1 MFM Modulator and Write Compensation Truth Table

| Shift Register Status |     |     |     | MFM & Write Comp. Data |     |    |    |           |     |    |    |
|-----------------------|-----|-----|-----|------------------------|-----|----|----|-----------|-----|----|----|
|                       |     |     |     | Data Bit               |     |    |    | Clock Bit |     |    |    |
| SR0                   | SR1 | SR2 | SR3 | EY1                    | EY2 | OT | LT | EY1       | EY2 | OT | LT |
| 0                     | 1   | 1   | *   | 1                      | 0   | 0  | 0  | 0         | 0   | 0  | 0  |
| 0                     | 1   | 0   | *   | 0                      | 1   | 0  | 0  | 0         | 0   | 0  | 0  |
| 1                     | 1   | 1   | *   | 0                      | 0   | 1  | 0  | 0         | 0   | 0  | 0  |
| 1                     | 1   | 0   | *   | 0                      | 0   | 0  | 1  | 0         | 0   | 0  | 0  |
| 1                     | 0   | 0   | 0   | 0                      | 0   | 0  | 0  | 1         | 0   | 0  | 0  |
| 1                     | 0   | 0   | 1   | 0                      | 0   | 0  | 0  | 0         | 1   | 0  | 0  |
| 0                     | 0   | 0   | 0   | 0                      | 0   | 0  | 0  | 0         | 0   | 1  | 0  |
| 0                     | 0   | 0   | 1   | 0                      | 0   | 0  | 0  | 0         | 0   | 0  | 1  |

\* = Don't Care

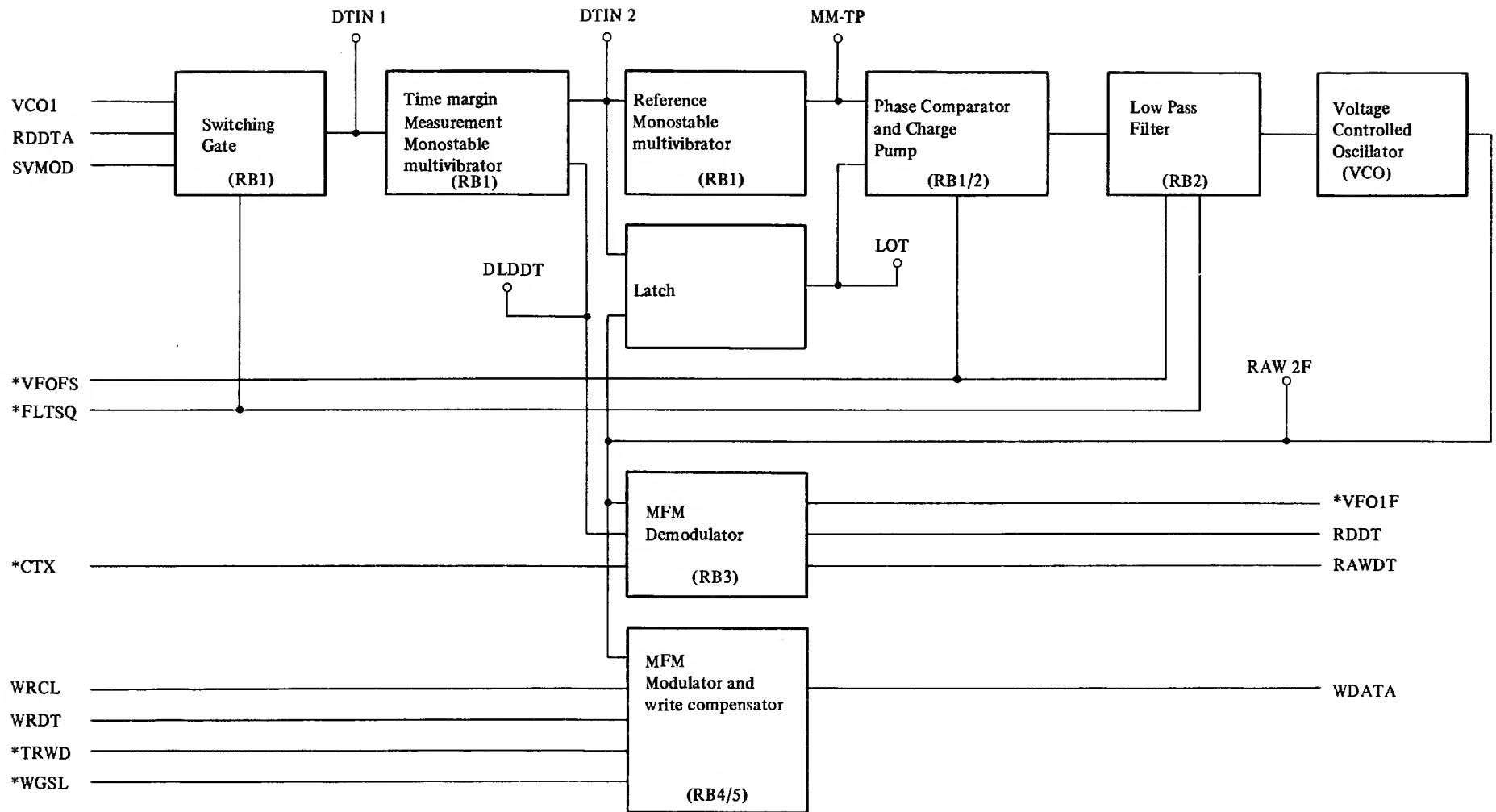


Fig. 11.1-1 VFO Block Diagram

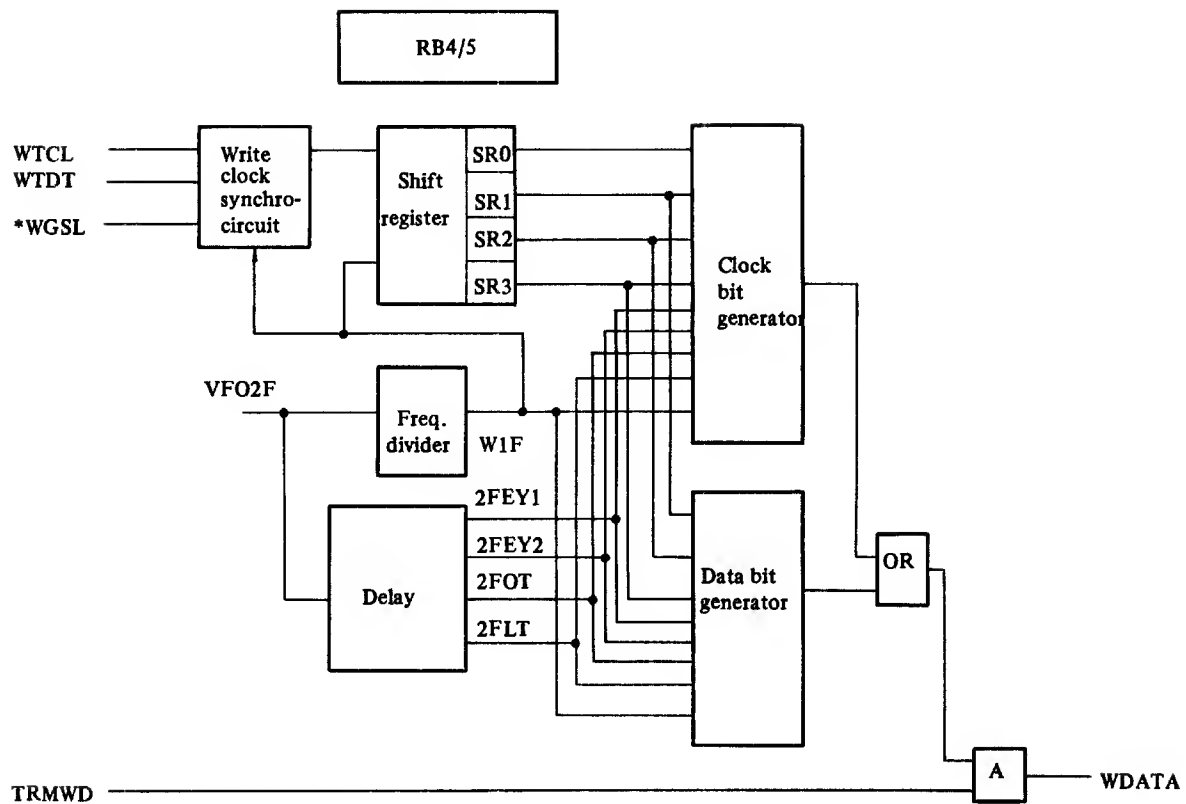


Fig. 11.1-2 MFM Modulator and Write Compensator Block Diagram

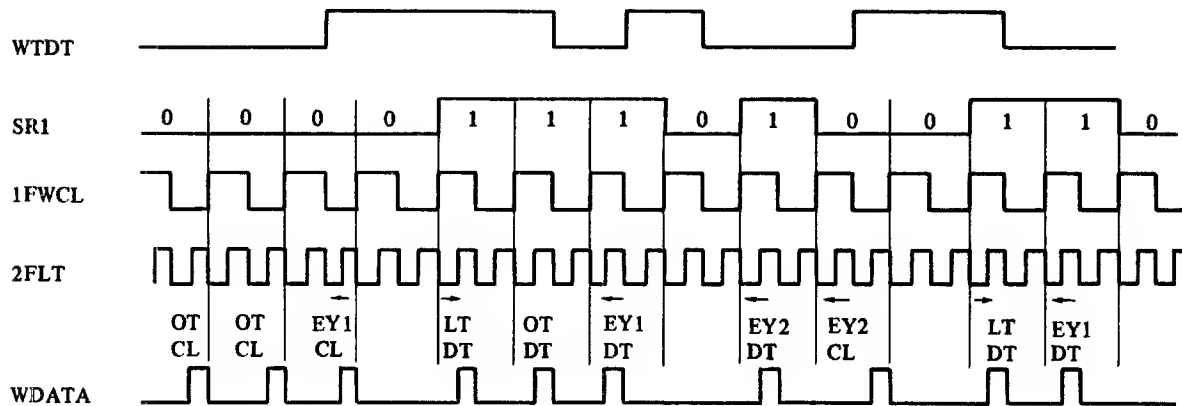


Fig. 11.1-3 MFM Modulator and Write Compensator Timing Chart

## 11.2 VFO AND MFM DEMODULATOR CIRCUIT

The Variable Frequency Oscillator (VFO) circuit synchronizes with a VCO1 signal from the servo track during a Not-Read operation, and with the Raw Data (RDDTA) signal from the data track during a Read operation. The block diagram of the VFO circuit is shown in Figure 11.1-1.

### (1) Switching Gate

The Switching Gate controls the VFO input. During an initial seek operation or a RTZ operation, this circuit inhibits an input data into the VFO circuit by enabling the Filter Squelch (\*FLTSQ).

This causes the VCO to oscillate at the free-running frequency. During a Not-Read operation, the VCO1 is applied to the VFO circuit by enabling the Servo Mode (SVMOD).

During a Read operation, the RDDTA is applied by disabling the SVMOD. The Switching Gate output, Data Input 1 (DTIN1), is applied to the Time-margin Measurement Monostable multivibrator (TMM) circuit.

### (2) Time-margin Measurement Monostable multivibrator (TMM)

The TMM circuit issues a Data Input 2 (DTIN2) to the Phase Comparator and the Latch, and it also issues a Delayed Data (DLDDT) to the MFM Demodulator. The timing relation between DTIN2 and DLDDT is adjusted by potentiometer RV6 and it determines the time-margin of read data.

### (3) Reference Monostable multivibrator

The positive-going edge of the DTIN2 triggers the Reference Monostable multivibrator, which issues 14 nsec Reference Pulse to the Phase Comparator and Charge Pump.

### (4) Latch

The positive going edge of the DTIN2 sets the Latch and the negative going edge of the RAW2F reset it.

The Latch issues Latch Output (LOT) to the Phase Comparator and Charge Dump circuit.



#### (5) Phase Comparator and Charge Pump

The Phase Comparator and Charge Pump circuit issues Decrease Frequency (DECFR) when the VFO input signal is leading, and an Increase Frequency (INCFR) when the VFO input signal is late, comparing the phase between DTIN2 and RAW2F.

The Charge Pump circuit, a constant-current driver, charges or discharges the capacitor in the Low Pass Filter circuit by INCFR or DECFR.

#### (6) Low Pass Filter

The Charge Pump output signal is applied to Low Pass Filter circuit which attenuate a high-frequency noise.

During an initial seek operation or a RTZ operation, the FLTSQ clamps the Charge Pump output to 0V to recalibrate the VFO function. During an initial data read operation, the VFO Fast Synchronization (\*VFOFS) is issued to the VFO circuit.

This increases the loop gain of the VFO circuit to widen the pull-in range and shorten the pull-in time for synchronization with input data.

The output of the Low Pass Filter is the control voltage signal (VCX).

#### (7) Voltage Controlled Oscillator (VCO)

The VCO circuit is controlled by the VCX.

The VCO output signal (RAW2F) frequency increases when the VCX goes high, and decreases when the VCX goes low.

#### (8) MFM Demodulator

The MFM Demodulator circuit generates NRZ Read Data (RDDT) and VFO1F Clock (VFO1F) from MFM Read Data.

The MFM Demodulator circuit is controlled by RAW2F, Delayed Data (DLDDT) and Count X (\*CTX) during the read operation.

### 11.3 PRINCIPLE OF SYNCHRONIZATION AND DEMODULATION

MFM Demodulator circuit block diagram is shown in Figure 11.3-1 and timing chart is shown in Figure 11.3-2. During a read operation, the RDDTA is applied to the VFO circuit by disabling the SVMOD signal.

The TMM circuit generates two output signals, the DTIN2 and the DLDDT, by triggering two monostable multivibrators at the positive going edge of the RDDTA.

The positive-going edge of the DTIN2 triggers the Reference Monostable multivibrator. The Reference Monostable multivibrator output signal (MM-TP) has a pulse width about 14 nsec, and the VFO circuit operates to synchronize the negative-going edge of the MM-TP with the positive going-edge of the RAW2F.

The 2F Main Clock (\*2FMCL) is derived from the RAW2F delayed by a delay line. The delay line supplies 2F Early 1, 2F Early 2, 2F On time and 2F Late clock signals which are used in the MFM Modulator and Write Compensation circuit.

The positive-going edge of the \*2FMCL clocks two Flip-Flops (FF1 and FF2). The FF1 and FF2 circuits divide the frequency of the \*RAW2F in two, and then the divided signals are used for the Pre-data Window (PRWD) and Data Window (DTWD).

The DLDDT can trigger FF3 to generate Separated Data (SPD) if the DTWD keeps high when the DLDDT goes high.

The FF3 is reset by Reset Pulse A (RSPA) when CTX is in active and is reset by Reset Pulse B (RSPB) when CTX is active.

The CTX can be activated only in a Gap and the SPD in a Gap must be read only logical zero, but if FF3 generates logical one signal as SPD during CTX is high, the RSPB is issued from AND Gate and force to change the phase of PRWD and DTWD 180 degrees. This causes the SPD to read all zeros.

The DTWD clocks the FF5 circuit relative to the PRRD and generates NRZ Read Data (RDDTA) synchronized with the VF01F clock. The FF5 output signal (RDDT) is held reset until Read Data Gate (\*RDDGT) goes low.

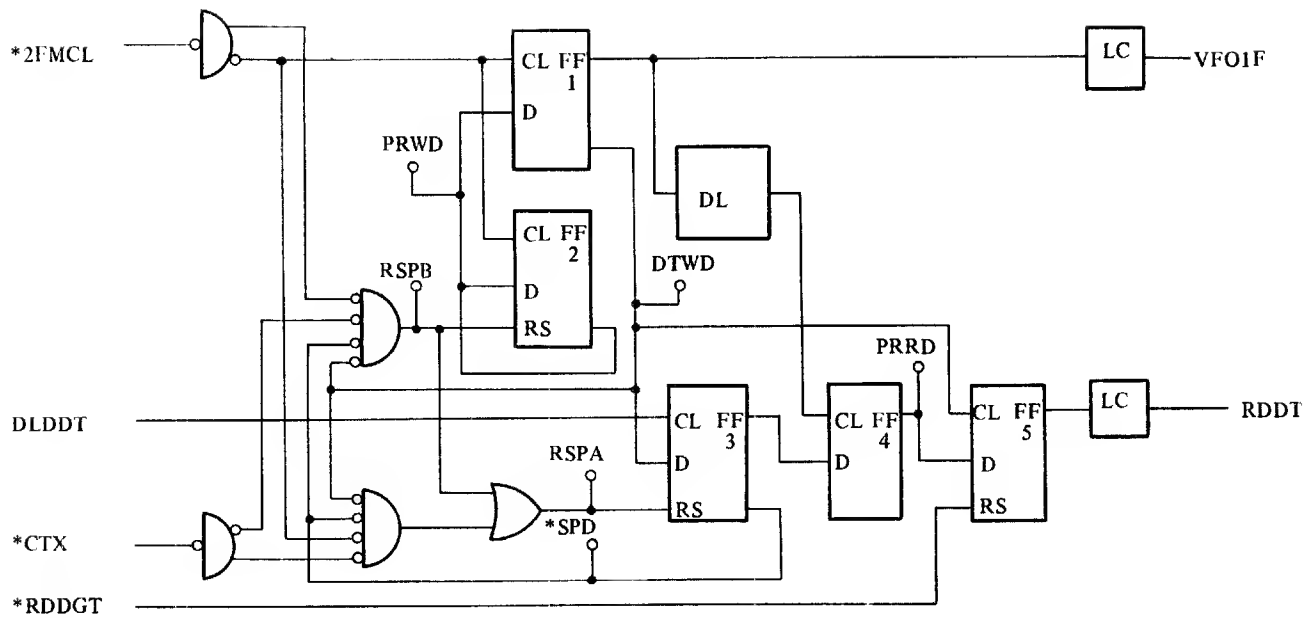


Fig. 11.3-1 MFM Demodulator Circuit Block Diagram

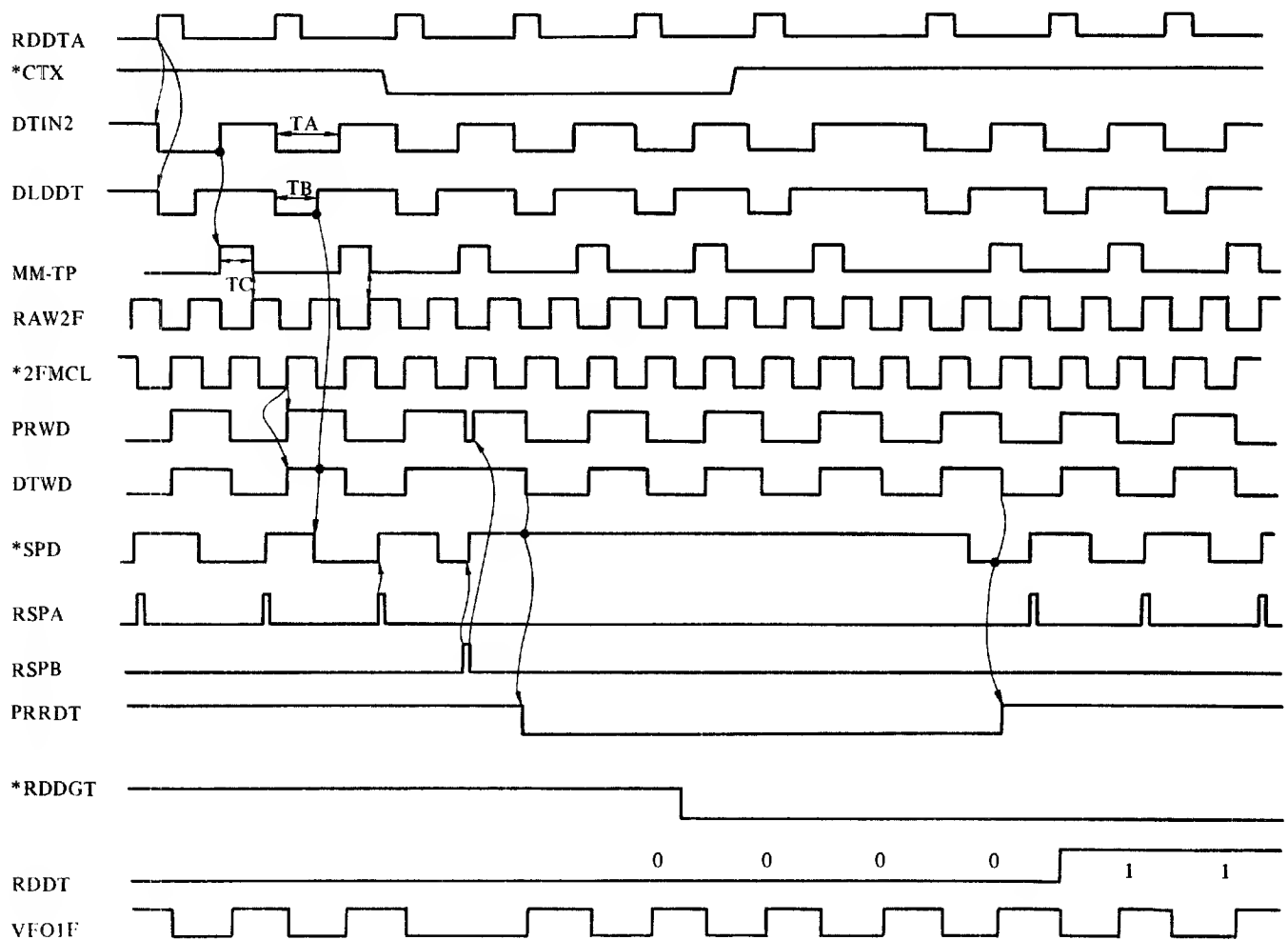


Fig. 11.3-2 MFM Demodulator Circuit Timing Chart

## 11.4 VFO CONTROL

### (1) Initial VFO Control

The VFO control circuit controls the input of the VFO circuit.

In a start up sequence, the initial seek completion sets a Servo Latch (SRVL), and then sets the Filter Squelch (\*FLTSQ) to enable the synchronization of the VFO circuit.

The leading edge of the SRVL triggers the initial VFO fast sync circuit, which issues 15-byte pulse of the \*VFOFS followed by a 1-byte pulse of the \*CTX.

The negative-going edge of \*VFOFS sets the Servo Mode Latch (SVMOD), which is applied to the VFO circuit, selecting the VCO1 as the VFO input data.

The timing chart of an initial VFO control is shown in Figure 11.4-1.

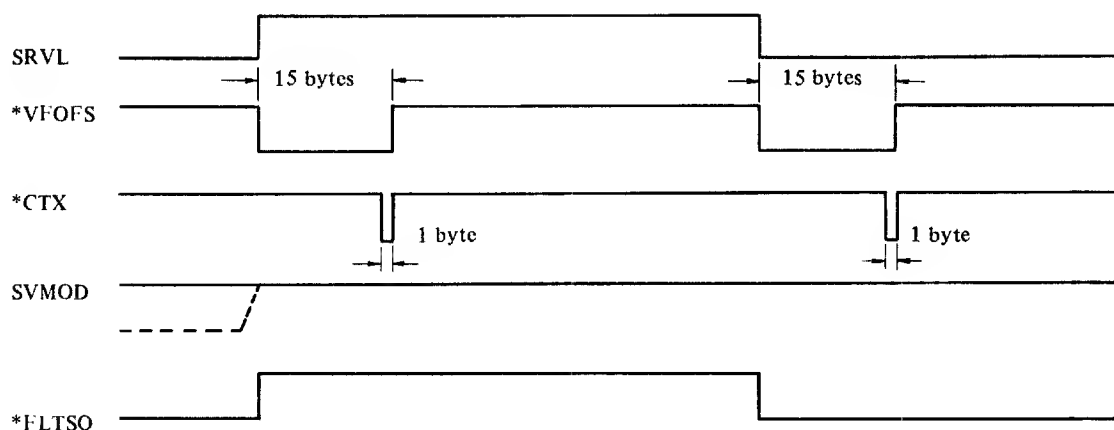


Fig. 11.4-1 Initial VFO Control Timing Chart

### (2) VFO Control in Fixed Sector Format

When executing a Read/Write operation, the VFO control circuit generates \*VFOFS, SVMOD and \*CTX signals triggered by negative and positive-going edges of the Read Gate Control signal (RGC).

The positive-going edge of RGC clocks the VFO control counter circuit to issue a 6-byte pulse of the \*VFOFS 7 bytes after the negative going edge of the RGC.

The negative going edge of the \*VFOFS sets the SVMOD. The RGC must be held low at least 1 byte or more in a read operation.

The VFO control in Fixed Sector Format timing chart is shown in Figure 11.4-2.

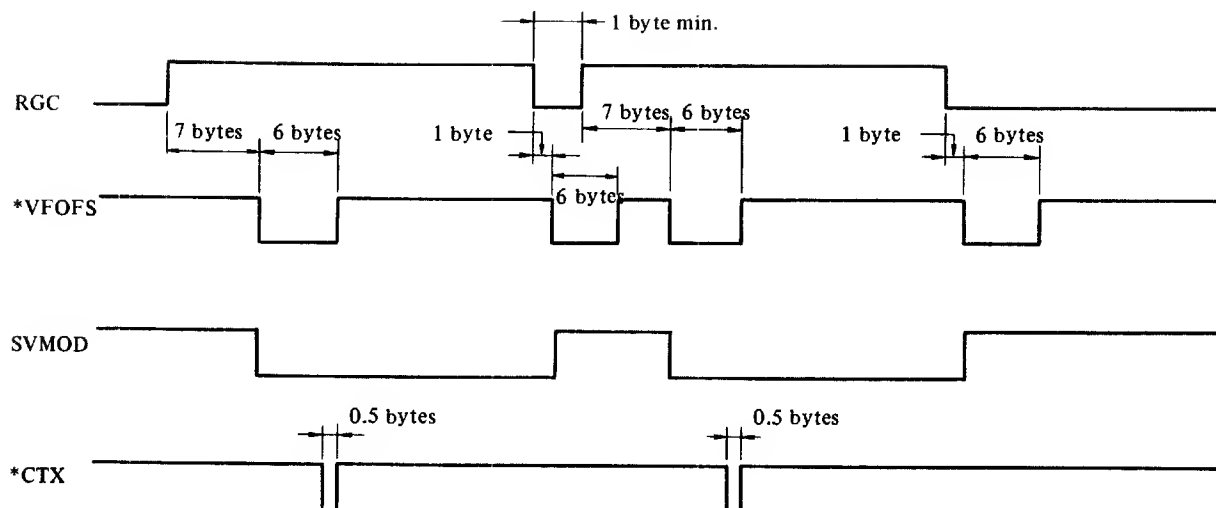


Fig. 11.4-2 VFO Control in Fixed Sector Format Timing Chart

### (3) VFO Control in Variable Sector Format

In Variable Sector Format, the controller issues AM Search to the drive. The drive circuit searches for an AM and, when found, issues AM Found (AMFD) with an 8-byte pulse to the controller.

The leading edge of the AMFD triggers the VFO control counter circuit to issue a 6-byte pulse of the \*VFOFS 7 bytes after the leading edge of the AMFD.

The remaining operation of the VFO control circuit is the same as that of the Fixed Sector Format.

The VFO control in Variable Sector Format timing chart is shown in Figure 11.4-3.

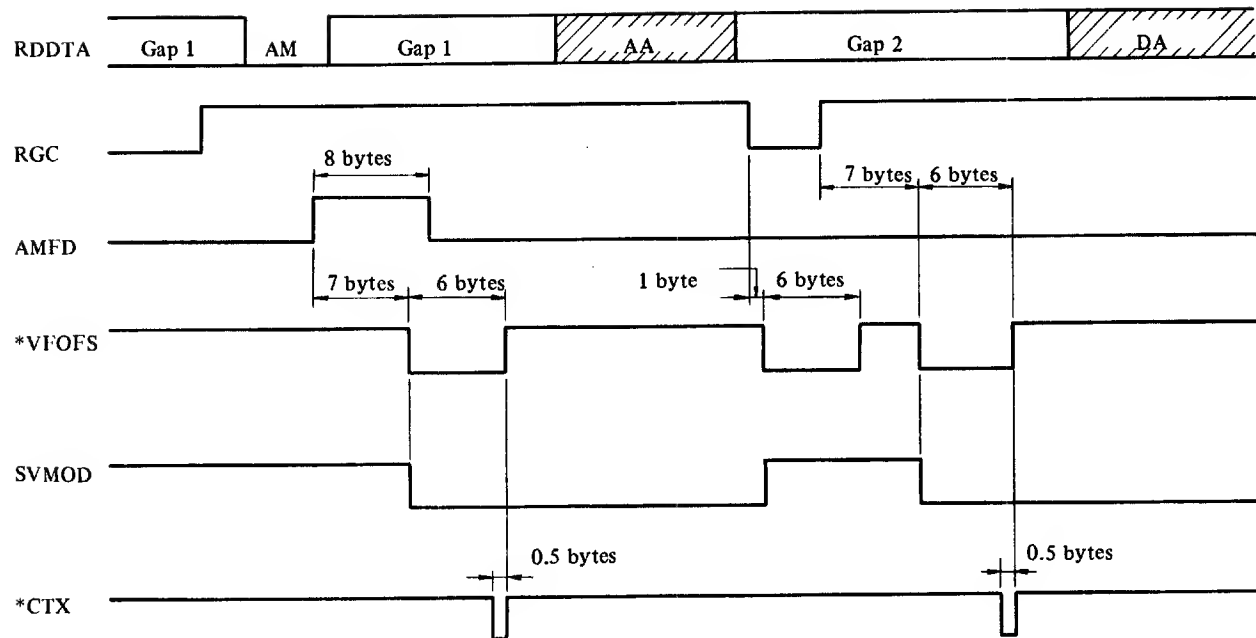


Fig. 11.4-3 VFO Control in Variable Sector Format Timing Chart



## CHAPTER 12 DC POWER SUPPLY UNIT

The DC Power Supply Unit receives input from a Single Phase AC power source and provides all voltages necessary for drive operation.

Reconfiguration for different input voltages is accomplished by changing the connections of the terminals located on the control panel of the unit. (Refer to Figure 2.2-1). The unit accepts 50Hz or 60Hz input frequency.

The power supply utilizes a multi-purpose 3 pole circuit breaker as the Main Line Switch. Two poles of this switch are used conventionally for primary power interrupt. One of these poles provides a contact closure for remote sensing of a tripped breaker. (TRM2 taps 4 and 5) The third pole is used for over-current protections of the 48 VDC supplied to the spindle and voice coil motors. It also has a trip coil which is used in the DC over-current/voltage and over-heat detection circuits noted in Table 12.3-1.

A sequence control circuit is incorporated. It remotely controls the start/stop operations of the spindle motor with the Pick and Hold signals in the interface cable.

The DC Power Supply Unit does not have a fan for cooling. It is cooled by the airflow from the line blower which cools the entire drive. When the Main Line Switch is turned on, AC power is supplied to this line blower.



## 12.1 INPUT REQUIREMENT

Input requirements of the DC power supply are those listed for the drive itself.  
(Refer to Table 1.5-1)

The drive is shipped with a power supply cable installed. Strain relief is provided by a cable clamp on the power supply control panel. Refer to Section 1.6.

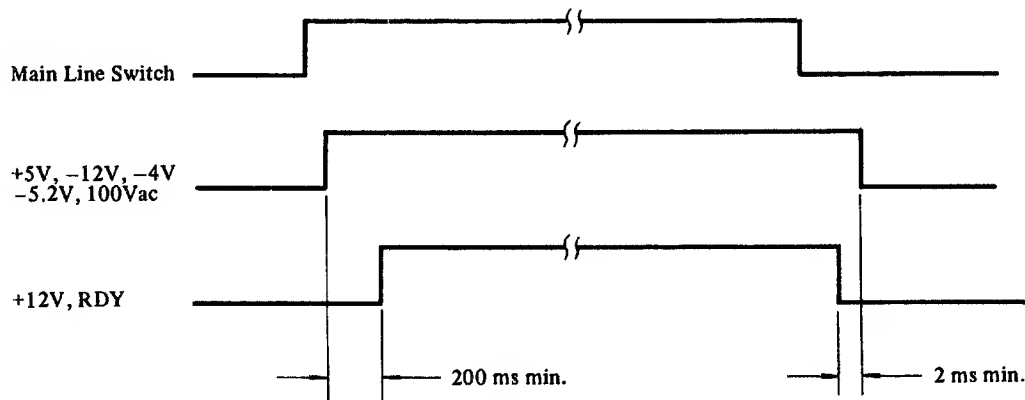


Figure 12.2-1 Output Sequence

## 12.2 OUTPUT CONDITIONS

Output conditions will be found in Table 12.2-1.

Table 12.2-1 Output Conditions

| Voltage  |                | Protection       |                  | Current                  | Variable<br>Range (%) | Usage                            |
|----------|----------------|------------------|------------------|--------------------------|-----------------------|----------------------------------|
| Vdc      | Tolerance<br>% | Over-<br>Voltage | Over-<br>Current | Adc                      |                       |                                  |
| +5       | ±4             | With             | With             | 4 ~ 5                    | ±5                    | PCBs                             |
| +12      | ±4             | Without          | With             | 0.3 ~ 1.0                | ±5                    |                                  |
| -12      | ±4             | Without          | With             | 0.3 ~ 0.5                | ±5                    |                                  |
| -4       | ±4             | Without          | With             | 0.2 ~ 1.3                | ±5                    |                                  |
| -5.2     | ±4             | Without          | With             | 3.0 ~ 6.0                | ±5                    |                                  |
| +48      | +20<br>-11     | Without          | With             | 3.3 ~ 5.3<br>(Peak; 9.6) |                       | Rotary Actuator<br>Spindle Motor |
| (100Vac) | +13<br>-15     | Without          | Without          | (0.8 Aac)                |                       | Line Blower                      |

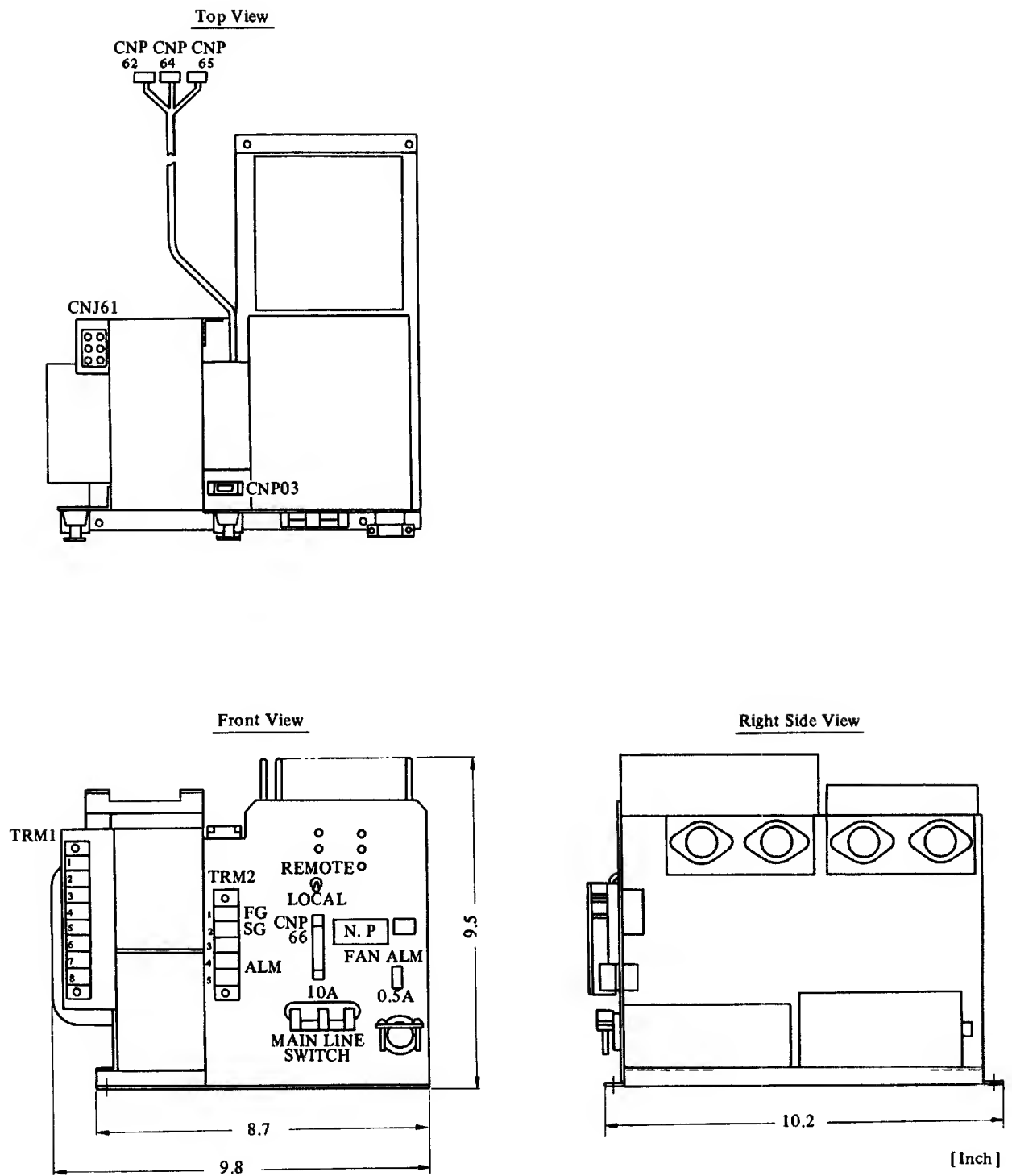
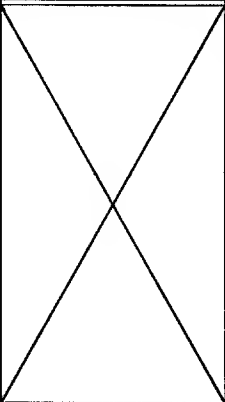


Figure 12.1-1 DC Power Supply Unit

### 12.3 ALARMS

The causes of various alarms and the indications when they occur are listed in Table 12.3-1.

Table 12.3-1 Alarm Indications

| Alarm       | Cause                             | Indication    |                                                                                    | (Note)                                                |
|-------------|-----------------------------------|---------------|------------------------------------------------------------------------------------|-------------------------------------------------------|
|             |                                   | Main Line Sw. | Fan Alm Fuse                                                                       |                                                       |
| Power Alarm | Over-current of AC input          | Tripped       |  |                                                       |
|             | Over-current/voltage of DC output |               |                                                                                    |                                                       |
|             | Overheat of transformer (139°C)   |               |                                                                                    | A thermal fuse embedded in the transformer blows out. |
|             | Overheat of heat-sink (90°C)      |               |                                                                                    |                                                       |
| Fan Alarm   | Stoppage of line blower           |               | Blown                                                                              |                                                       |

## 12.4 CONTROL OF SPINDLE MOTOR

The start/stop operations of the spindle motor are under control of sequence circuit in DC power supply unit. It is described in Figure 12.4-1 and 12.4-2.

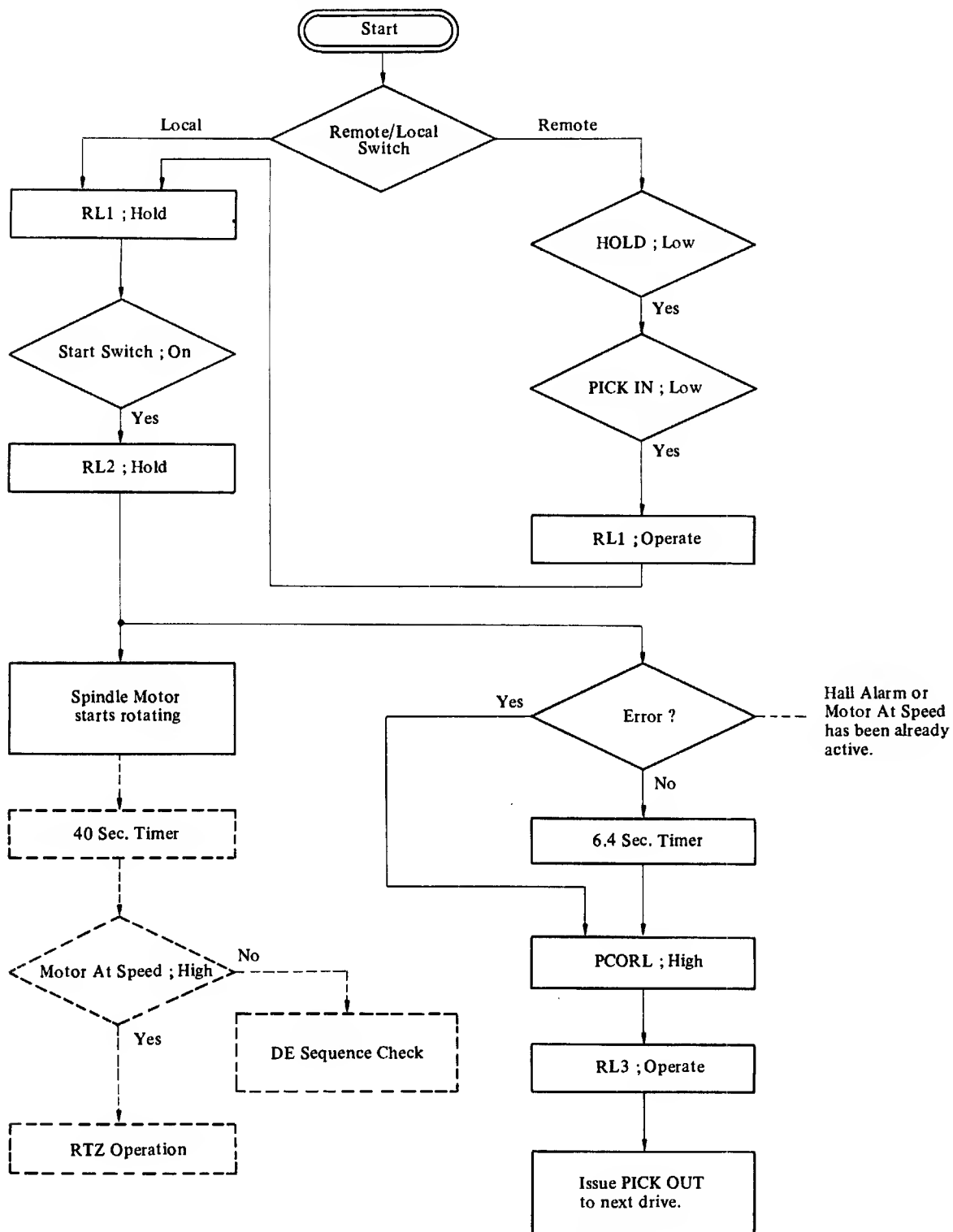


Figure 12.4-1 Flow Chart of Spindle Motor Control

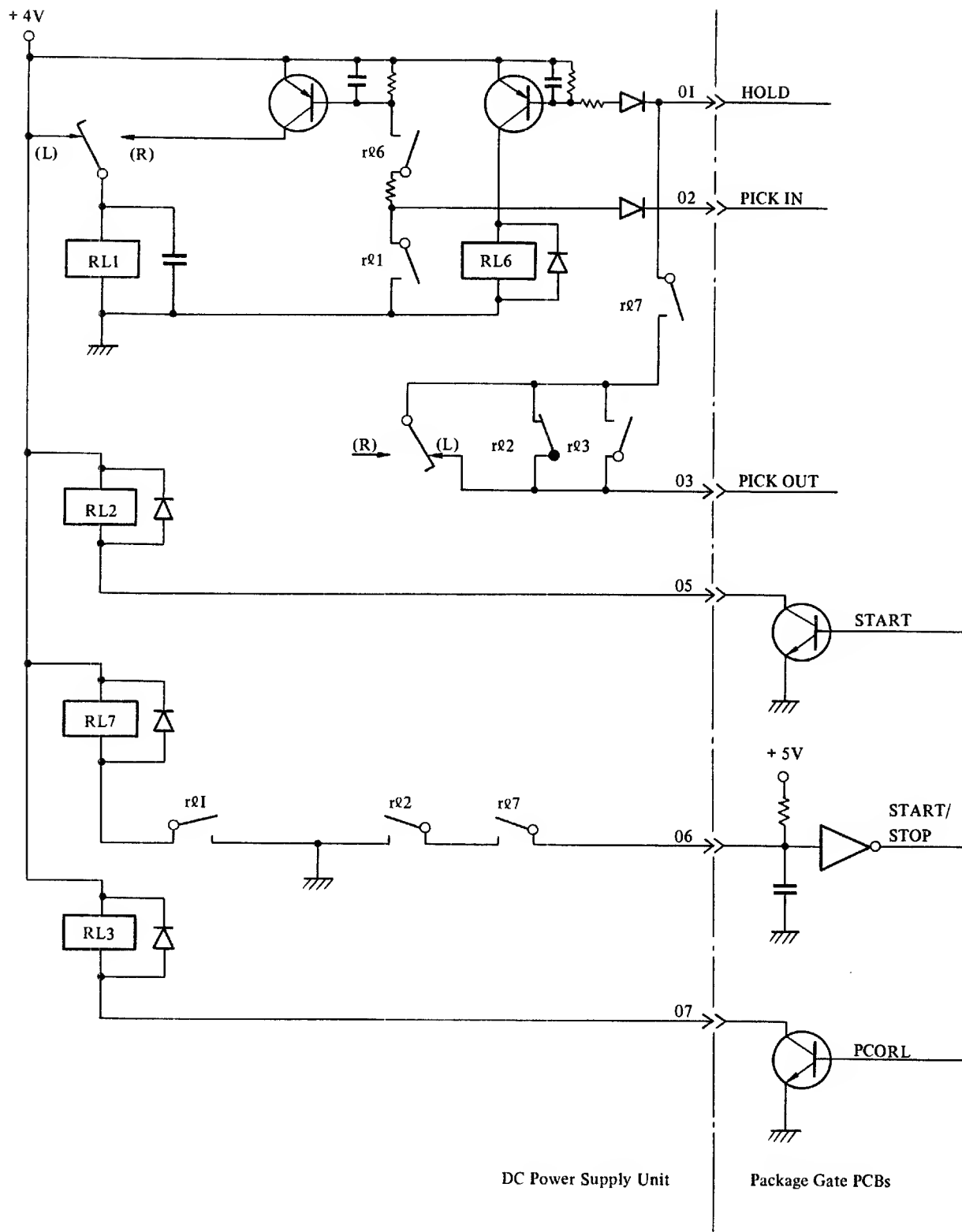


Figure 12.4-2 Spindle Motor Control Circuit

## 12.5 OPERATION

A functional block diagram will be found in Figure 12.5-1.

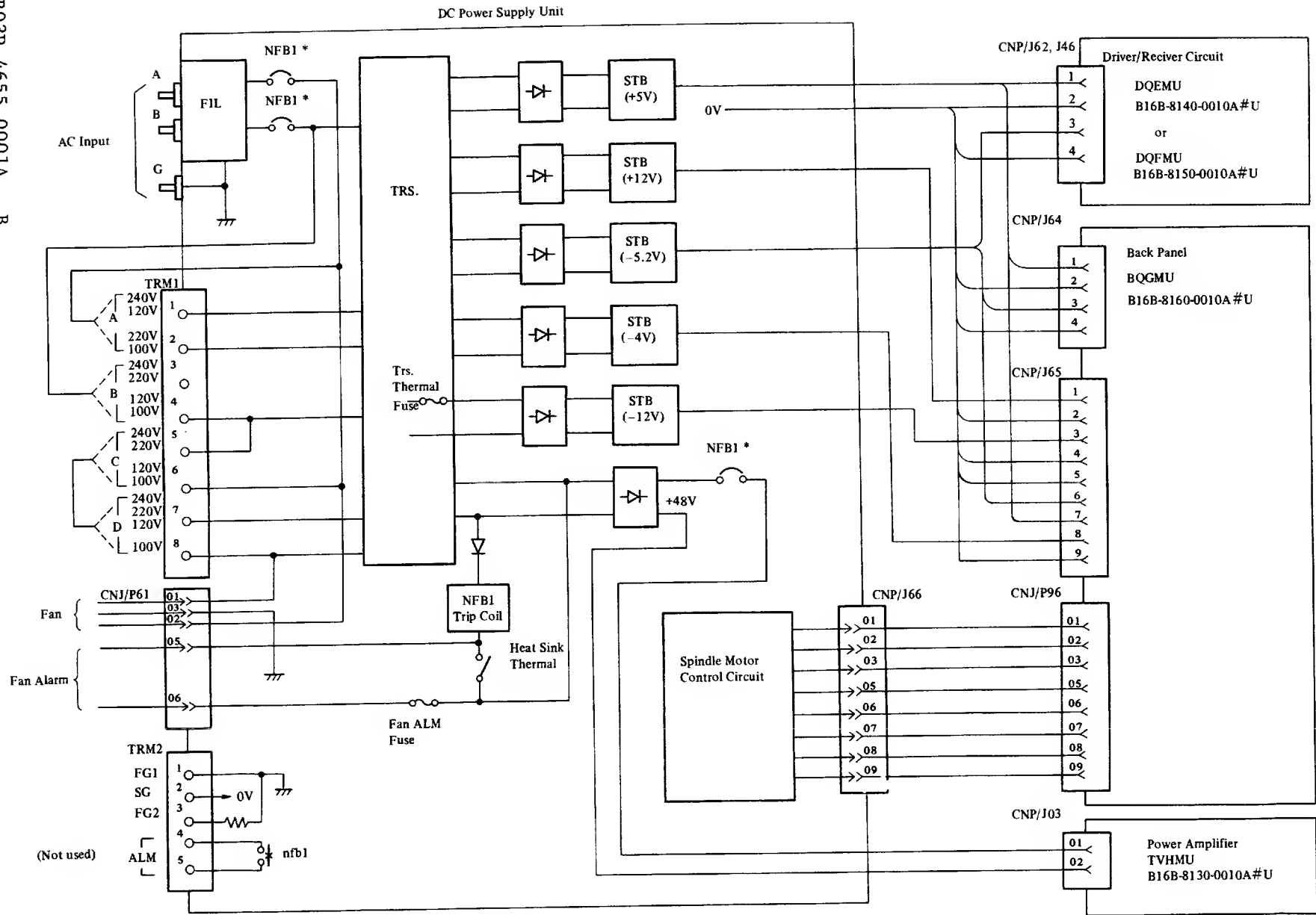


Figure 12.5-1 Functional Block Diagram of the DC Power Supply Unit



## CHAPTER 13 MAINTENANCE AND PARTS REPLACEMENT

This chapter covers the maintenance of the drive, namely, general precautions and replacement procedures (including options).

### 13.1 GENERAL PRECAUTIONS

#### (1) Power ON/OFF

- Check the operating condition of the drive before turning the power on or off.
- Before turning the power on after the maintenance has been finished, check that all parts are properly Re-assembled.

#### (2) Removing/Installing connectors

- Always turn the power off before removing or inserting connectors.
- Verify all connectors are inserted correctly.

#### (3) Replacement

- Use screwdrivers, wrenches and other tools suitable for the screws and bolts to be installed or removed.
- Do not leave removed screws in the drive.
- Tighten all screws with proper torque.

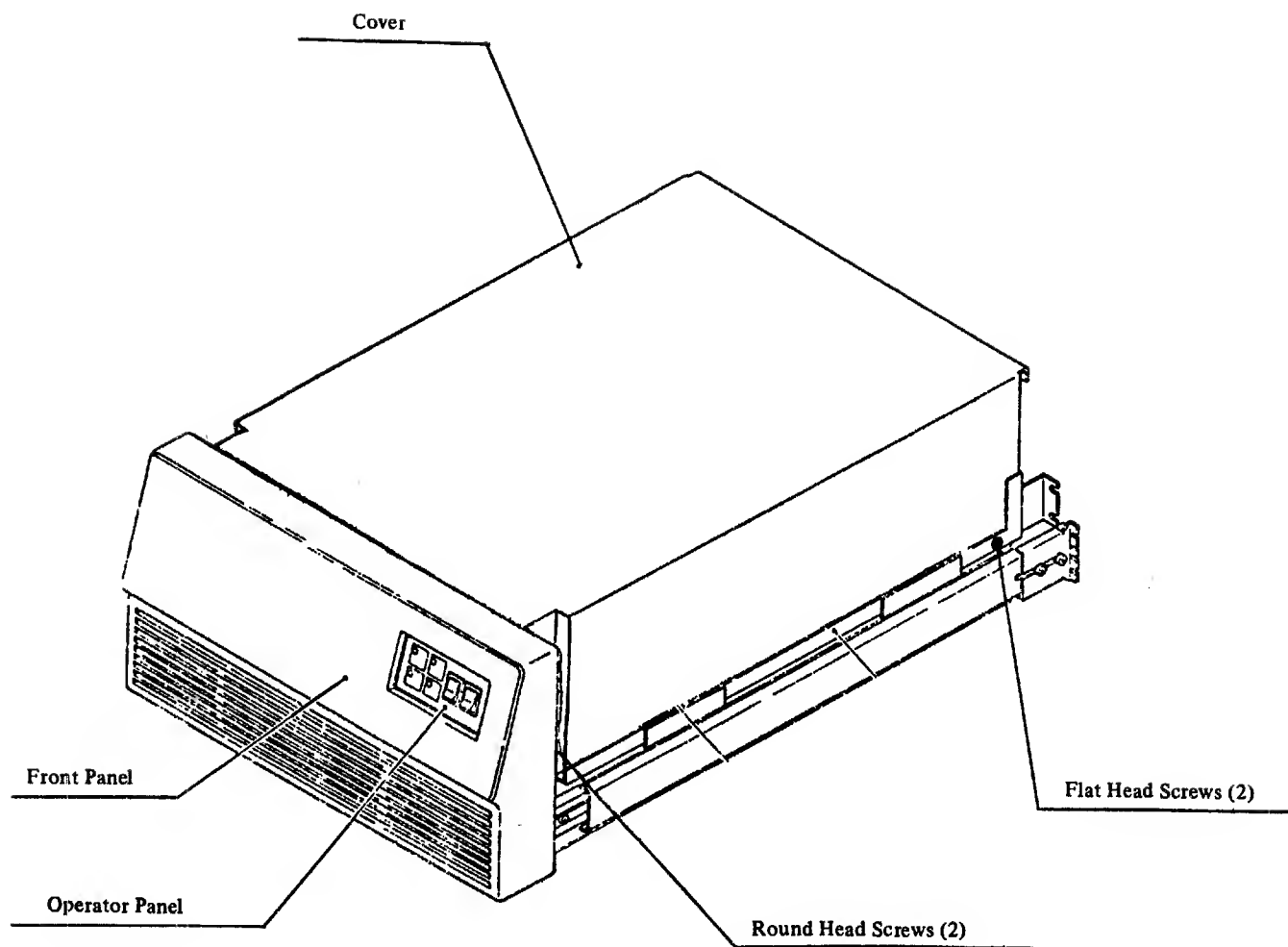
#### (4) Others

- Use test equipment which is calibrated correctly.
- Always record the trouble-shooting data for later reference.

#### (5) Replacement of Mechanical Parts

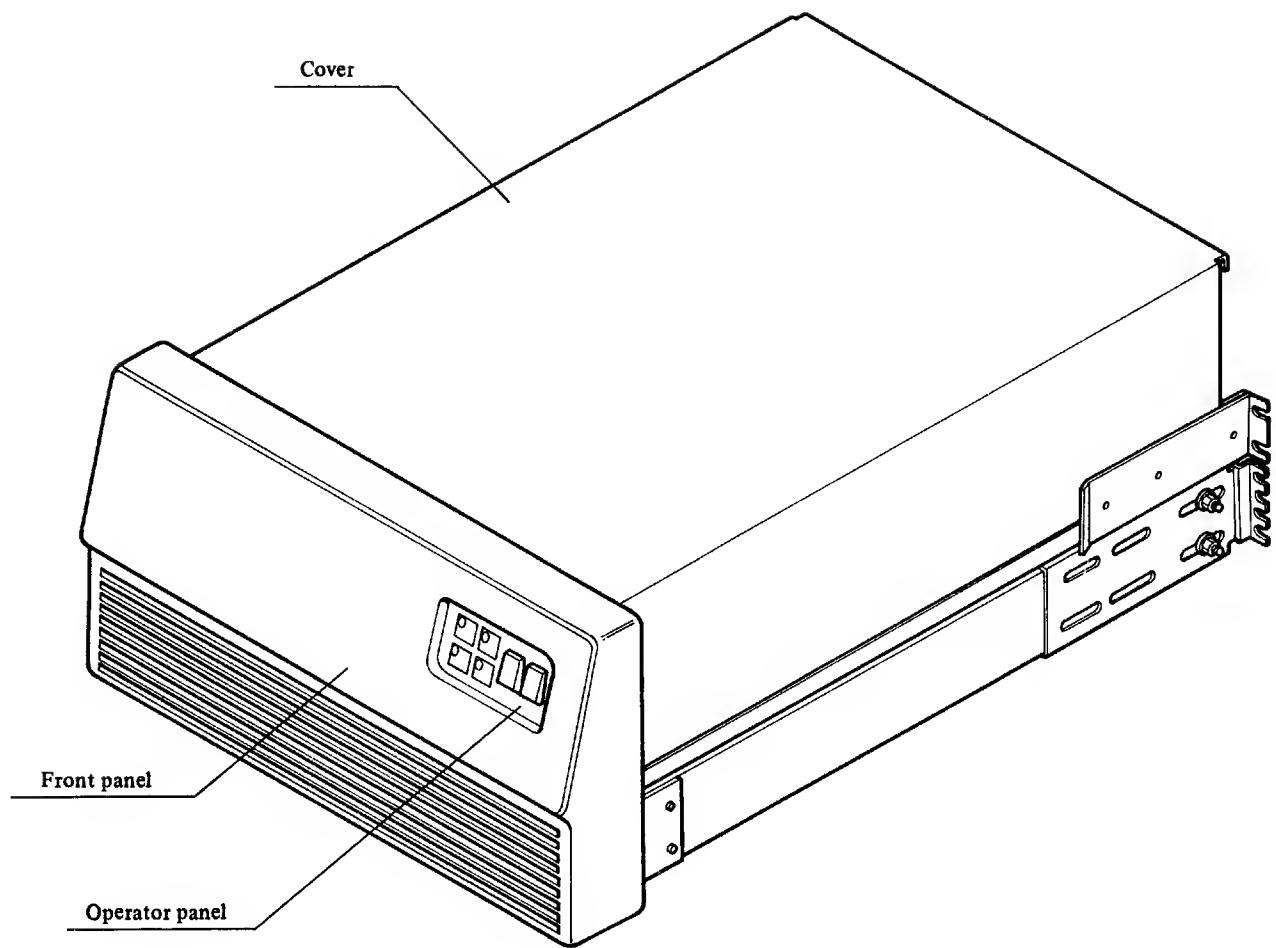
Prior to the replacement of mechanical parts, fully extend the drive and remove the cover. The cover is held by 4 screws. Always lock the rotary actuator when replacing mechanical parts.





(a) Early version

Figure 13.1-1 Exterior View of M2351 DKU



(b) Current version

Figure 13.1-1 - Continued

## 13.2 DE REPLACEMENT

### 13.2.1 DE replacement of old version

#### (1) REMOVAL

1. Lock the rotary actuator. (Refer to 2.3)
2. Remove the Plastic Cover.
3. Disconnect CNJ01, CNJ02, CNJ03, CNP504 and CNP505 from the TVHMu PCB.
4. Remove the 6 screws (Refer to Figure 13.2-1 ~~A~~) holding the TVHMu PCB and remove the entire TVHMu PCB.
5. Remove the 4 screws (Refer to Figure 13.2-1 ~~A~~) holding the TVHMu mounting bracket.
6. If it's a single port drive, remove CNP44 and CNP45 cables to clear the DE area.
7. If the Dual Channel option is installed, remove CNJ56, CNJ62, CNP54, CNP55, CNP57 and CNP59 from DQFMU PCB. (Refer to 13.8-(2))
8. Remove the DQFMU PCB by removing 4 screws and locate cables so as to clear the DE area. (Refer to 13.8-(2))
9. Remove CNJ506 and CNJ508 from the side of the DE.
10. Remove the three hexagon socket-head bolts (Refer to Figure 13.2-1, \* ) from the shock mounts.
11. Carefully lift the DE from the drive. Three cables will come out with the DE. Use care because the DE weighs approximately 58 lb, (25kg).

#### (2) INSTALLATION

1. To install a DE, be sure the three cables (CNJ502, CNJ504 and CNJ505) are attached/connected and held to the sides of the DE.
2. Gently Lower the DE on the shock mounts, taking care to watch the area all around the DE so cables aren't pinched.
3. Follow, in reverse order, the instructions for removal.

Note: The three hexagon socket-head bolts must be tighten at the torque of about 120 kg.cm.

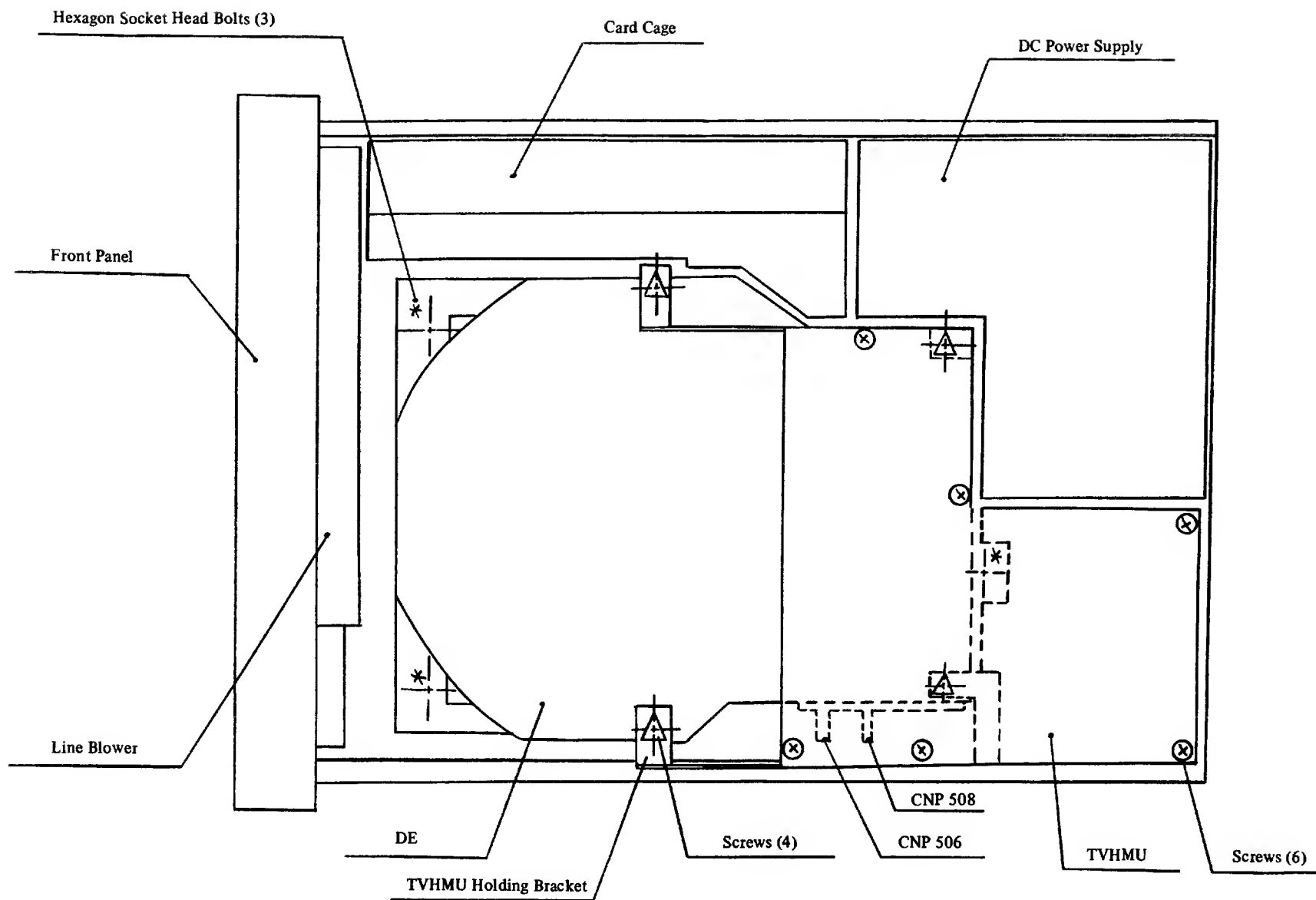


Figure 13.2-1 DE Replacement (Top View) . . . . Early version

### 13.2.2 DE replacement of New version

#### (1) REMOVAL

1. Lock the rotary actuator. (Refer to 2.3)
2. Remove the cover by removing two screws.
3. Disconnect CNJ02, CNP504 and CNP505 from the TVKMU PCB.
4. Remove the screw (Refer to Figure 13.2-1) and the wire.
5. If it's a single port drive, remove CNP45 cable to clear the DE area.
6. If the Dual Channel option is installed, remove CNJ56, CNJ62, CNP54, CNP55, CNP57 and CNP59 from DQFMU PCB. (Refer to 13.8-(2))
7. Remove the DQFMU PCB by removing 4 screws and locate cables so as to clear the DE area. (Refer to 13.8-(2))
8. Remove CNJ506 and CNJ508 from the side of the DE.
9. Remove the three hexagon socket-head bolts (Refer to Figure 13.2-1, \*) from the shock mounts.
10. Carefully lift the DE from the drive. Three cables will come out with the DE. Use care because the DE weighs approximately 58 lB, (25 kg).

#### (2) INSTALLATION

1. To install a DE, be sure the cable (CNJ502, are attached/connected and held to the sides of the DE.
2. Gently Lower the DE on the shock mounts, taking care to watch the area all around the DE so cables aren't pinched.
3. Follow, in reverse order, the instructions for removal.

Note: The three hexagon socket-head bolts must be tighten at the torque of about 120 kg·cm.

4. Make dynamic adjustments of Servo Circuit Refer 14.2-(3).

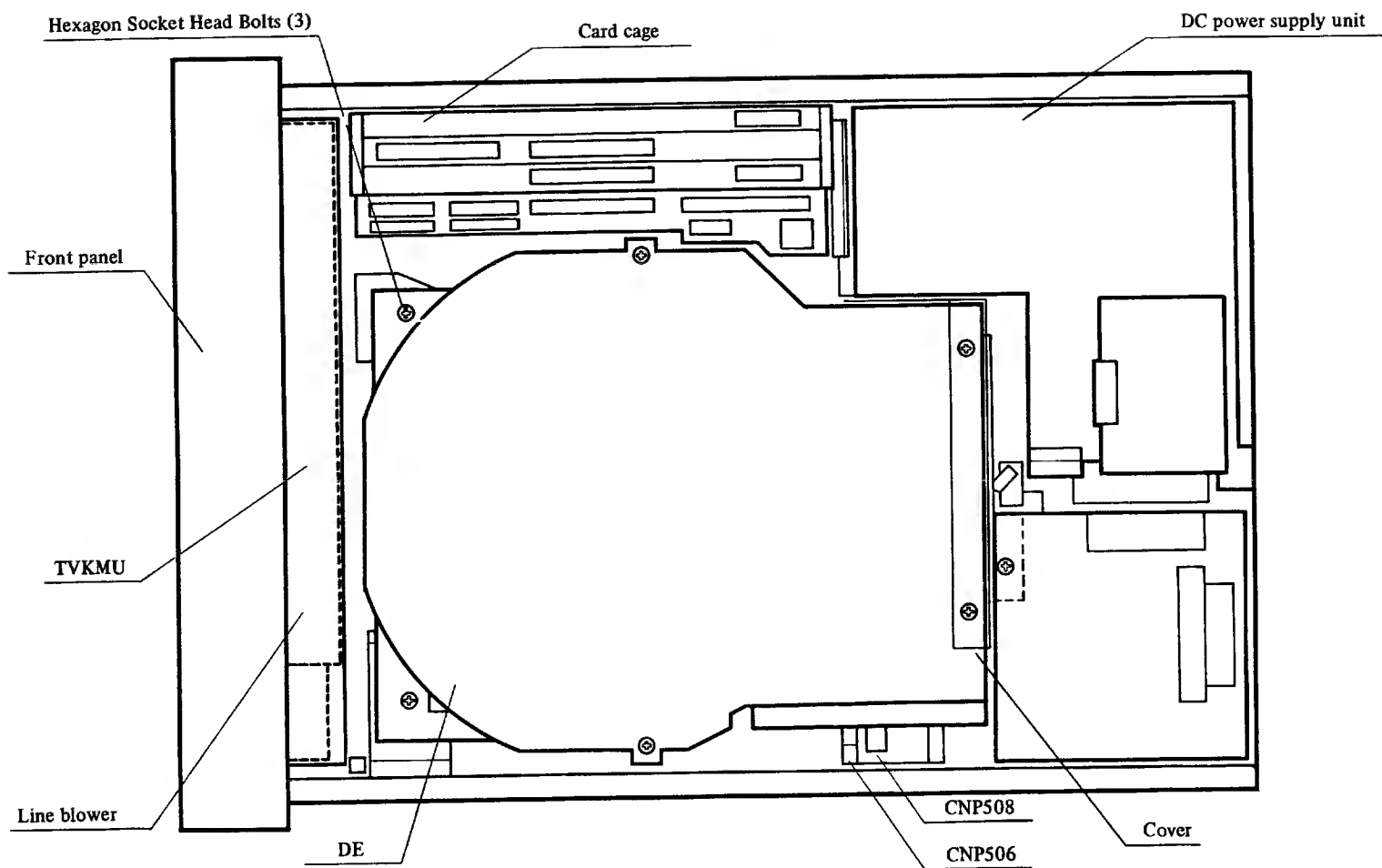


Figure 13.2-2 DE Replacement (Top View) . . . . Current version

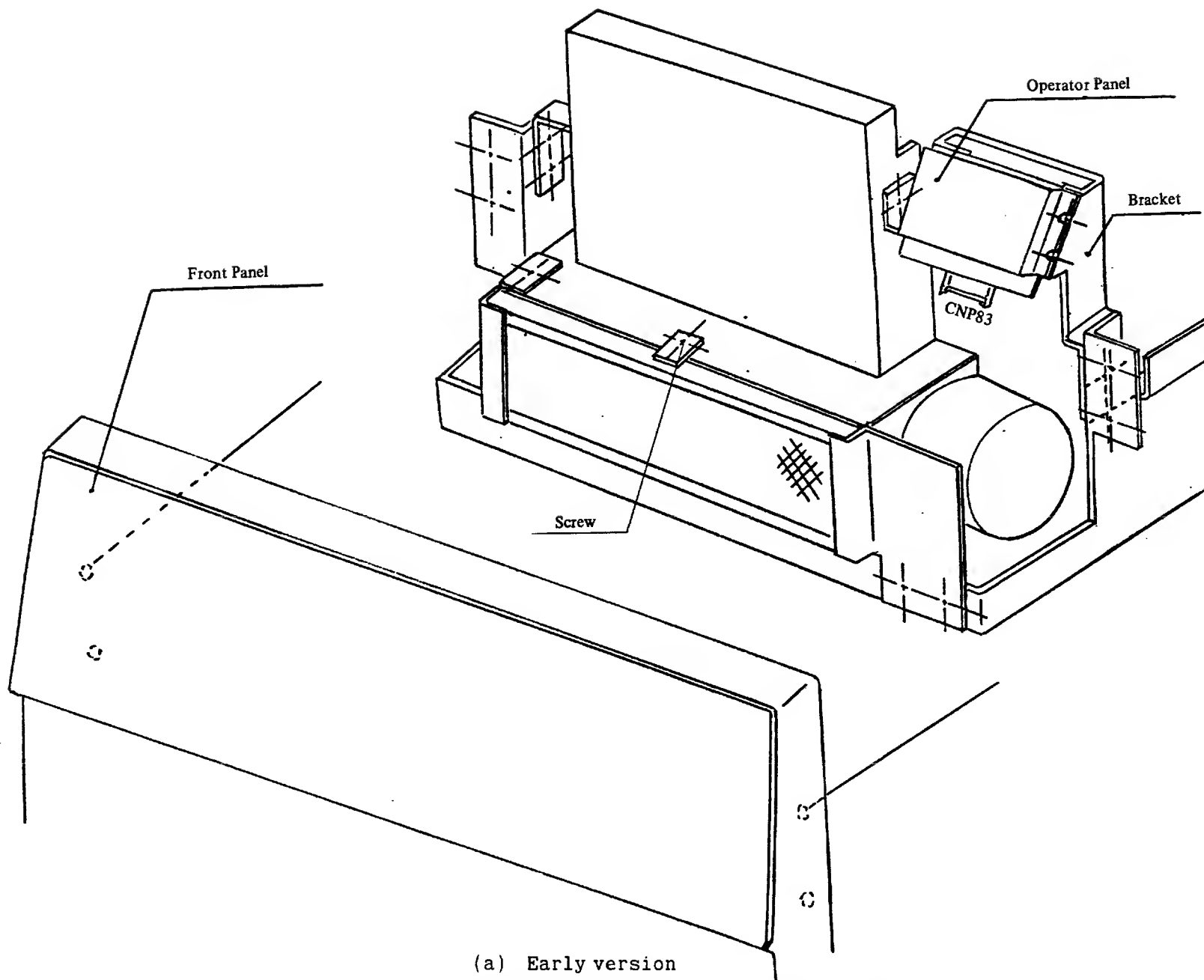
### 13.3 FRONT PANEL AND OPERATOR PANEL

#### (1) Removal

1. Remove the 4 screws holding the front panel to the frame.
2. Remove CNP83 from the Operator Panel PCB, and remove the 4 screws holding the Operator Panel to the bracket.

#### (2) Installation

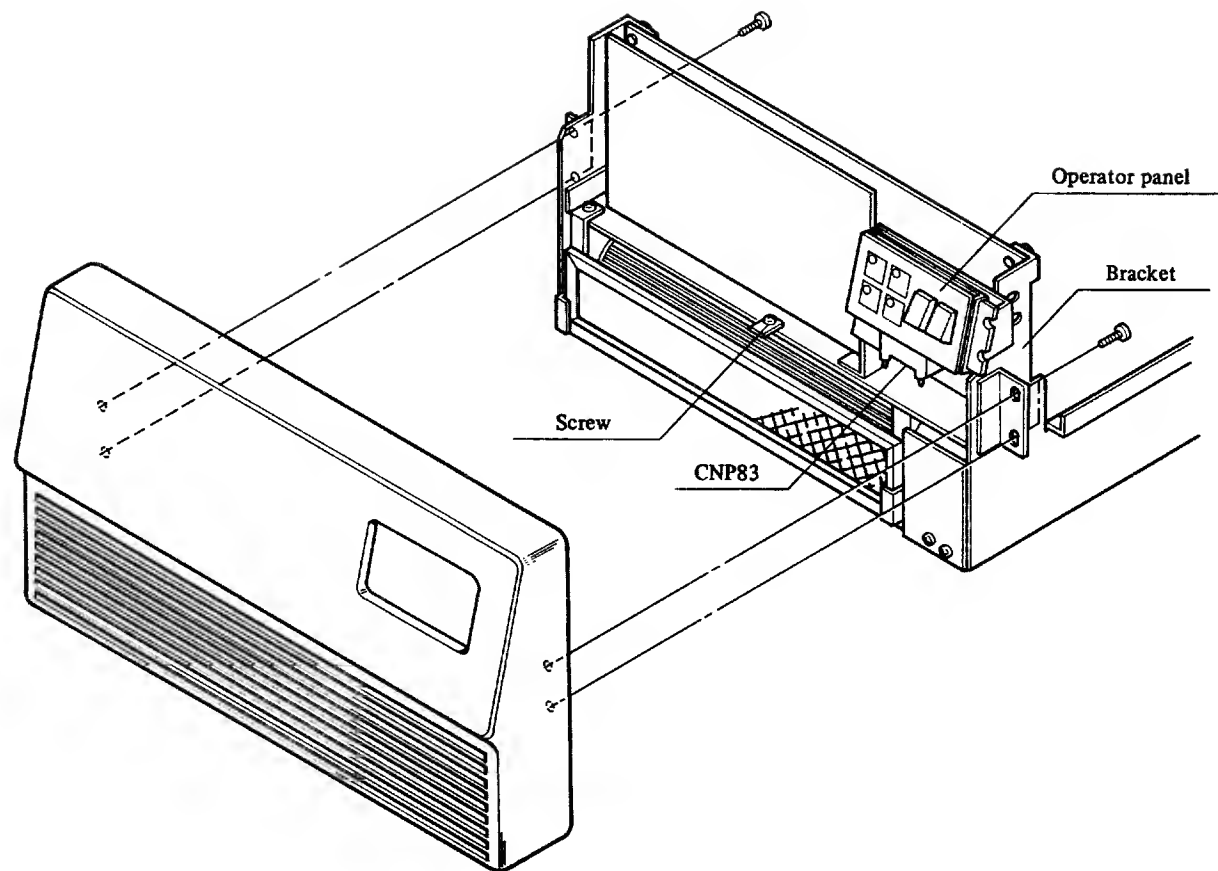
1. Follow, in reverse order the procedure for removal.



(a) Early version

Figure 13.3-1 Front Panel and Operator Panel Removal





(b) Current version

Figure 13.3-1 - Continued

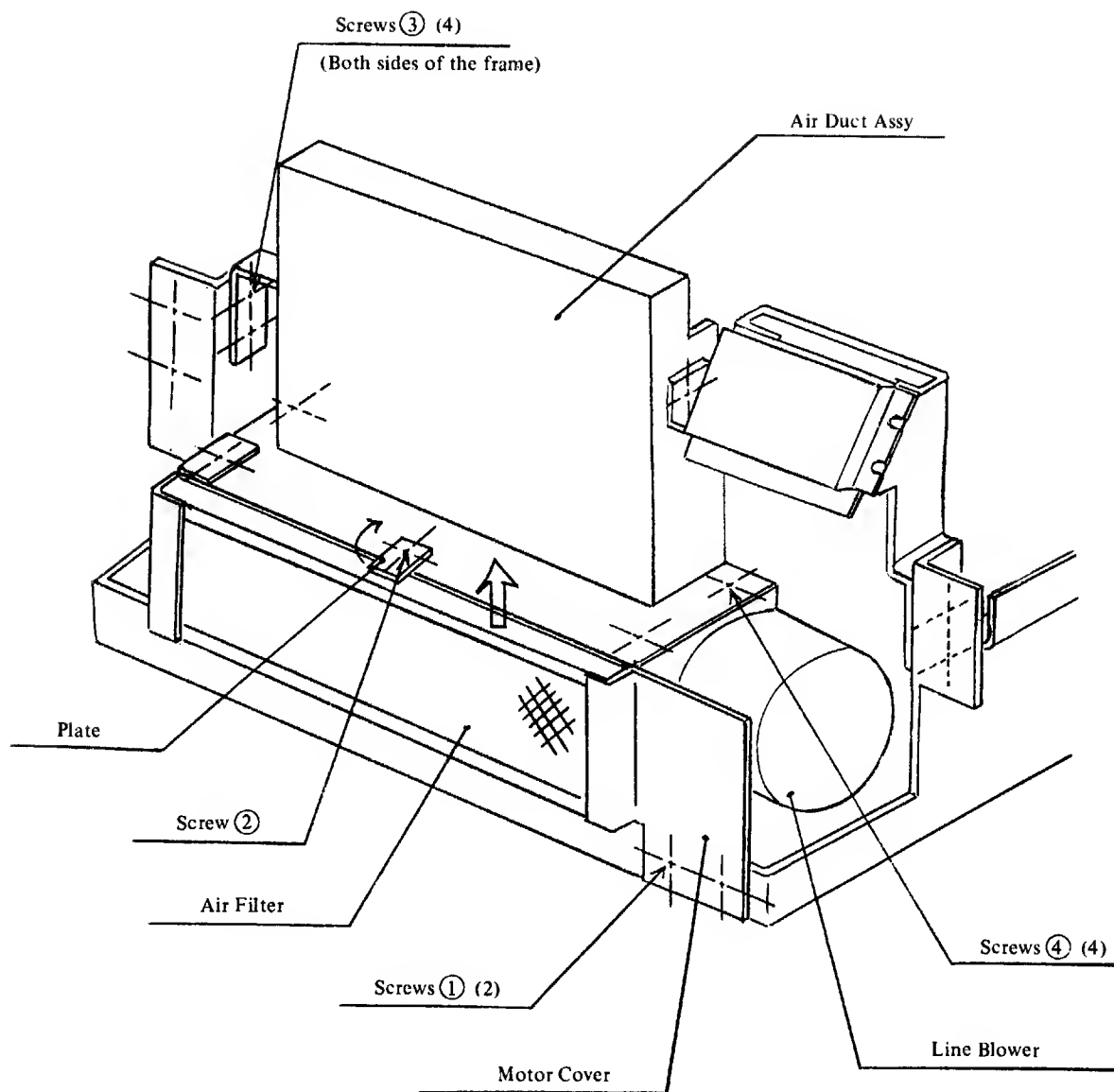
## 13.4 AIR FILTER

### (1) Removal

1. Remove the front panel. (Refer to 13.3-(1))
2. Loosen a screw and rotate the plate.
3. Remove the Air Filter by pulling it in directions of arrow in Figure 13.4-1.

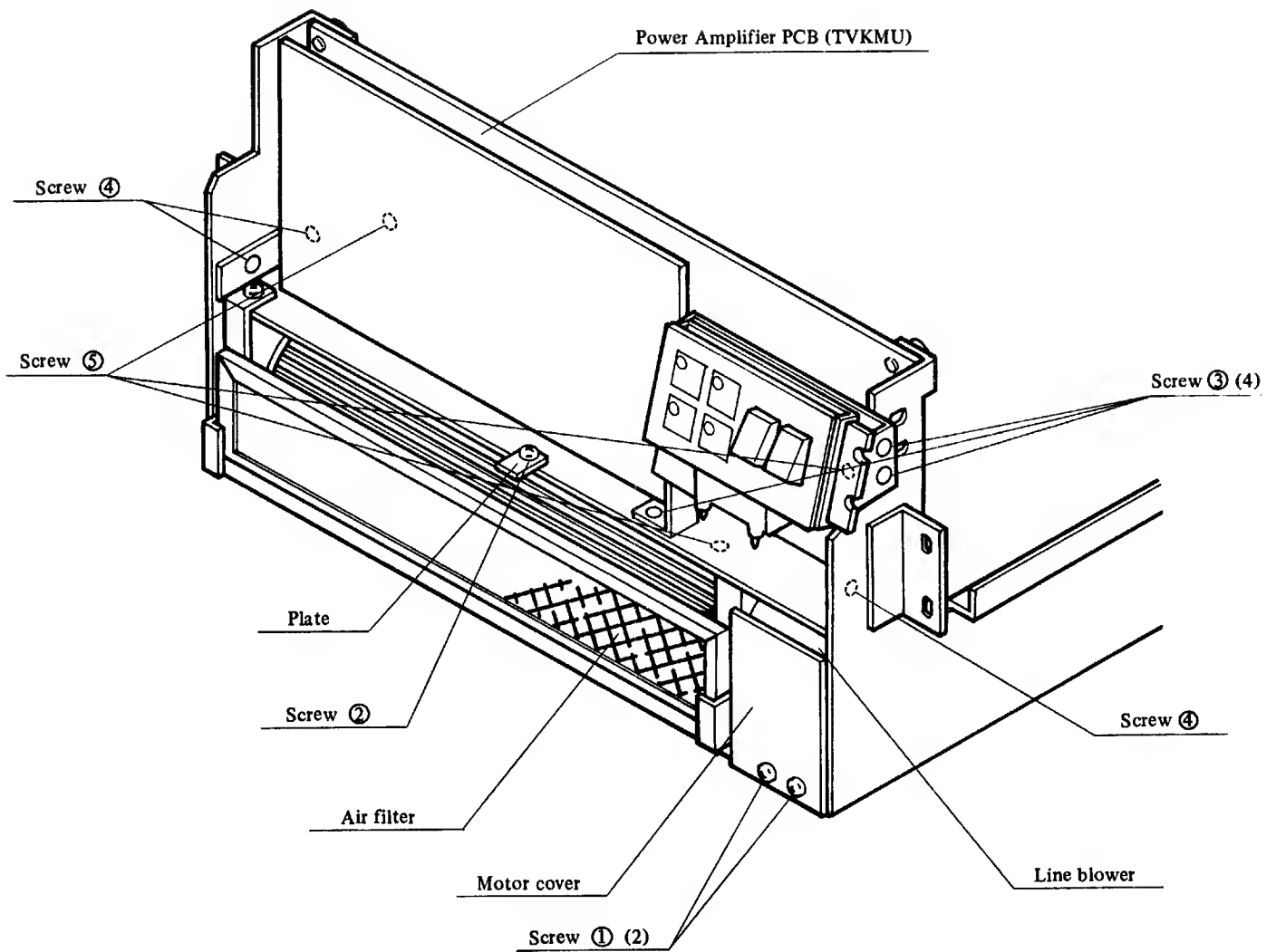
### (2) Installation

1. Insert the Air Filter in front of the Line Blower.
2. Rotate the plate to upper position of the Air Filter and fasten the screw.
3. Install the front Panel (Refer to 13.3-(2))



(a) Early version

Figure 13.4-1 Air Filter and Line Blower Replacement



(b) Current version

Figure 13.4-1 - continued

## 13.5 LINE BLOWER

### 13.5.1 Early version (Refer to Figure 13.4-1 (a))

#### (1) Removal

1. Remove the front Panel (Refer to 13.3-(1)).
2. Remove the 2 screws (①) holding the motor cover and remove this cover.
3. Rotate the screw (②) and remove the air filter.
4. Remove the 4 screws (③).
5. Disconnect the motor plug, CNP71. Remove the 4 screw (④) and lift the air duct assy slightly, and remove the line blower forward.

#### (2) Installation

1. Follow, in reverse order, the procedure for line blower removal.

### 13.5.2 Current version (Refer to Figure 13.4-1 (b))

#### (1) Removal

1. Remove the front Panel (Refer to 13.3-(1)).
2. Remove the 2 screws (①) holding the motor cover and remove this cover.
3. Rotate the screw (②) and remove the air filter.
4. Remove the 4 screws (③), holding the operator panel bracket and remove this panel assy.
5. Remove the TVKMU pulling out two fastening latches.
6. Remove the 4 screws (④).
7. Disconnect the motor plug, CNP71. Remove the 4 screw (⑤) and remove the line blower forward.

#### (2) Installation

1. Follow, in reverse order, the procedure for line blower removal.

## 13.6 BACK PANEL (BQGMU)

### (1) Removal

1. Remove the PCBs from the card cage.
2. Remove screws (2) and then, lift the card cage vertically.  
Rotate over the side and remove all connectors (9) to back panel.
3. Remove nuts (4) washers (8) (Refer to Figure 13.6-1).
4. Remove the card cage and 7 screws (7).
5. Remove the back panel.

### (2) Installation

1. Follow, in reverse order, the procedure for back panel removal.

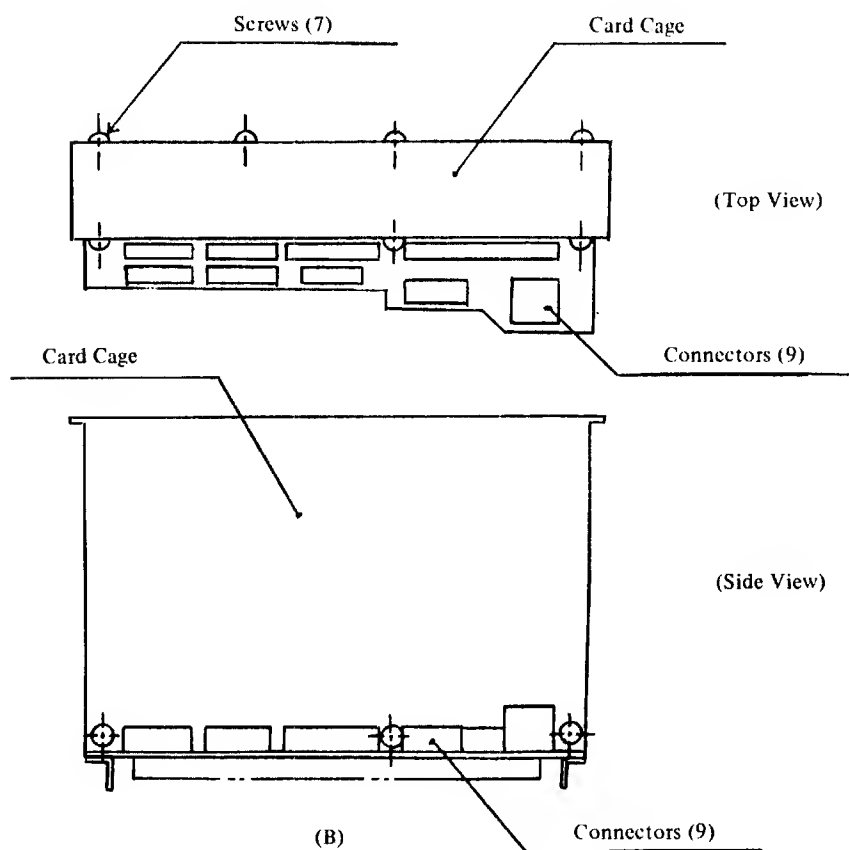
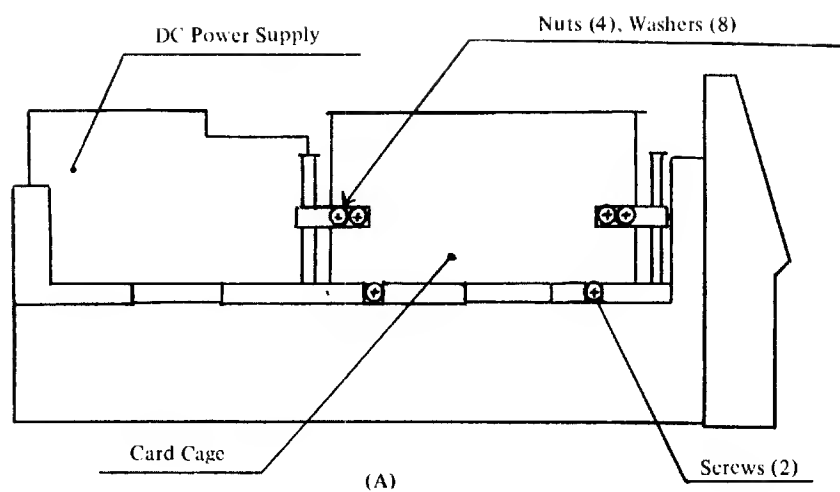


Figure 13.6-1 Back Panel Replacement

## 13.7 HOUR METER

### (1) Installation

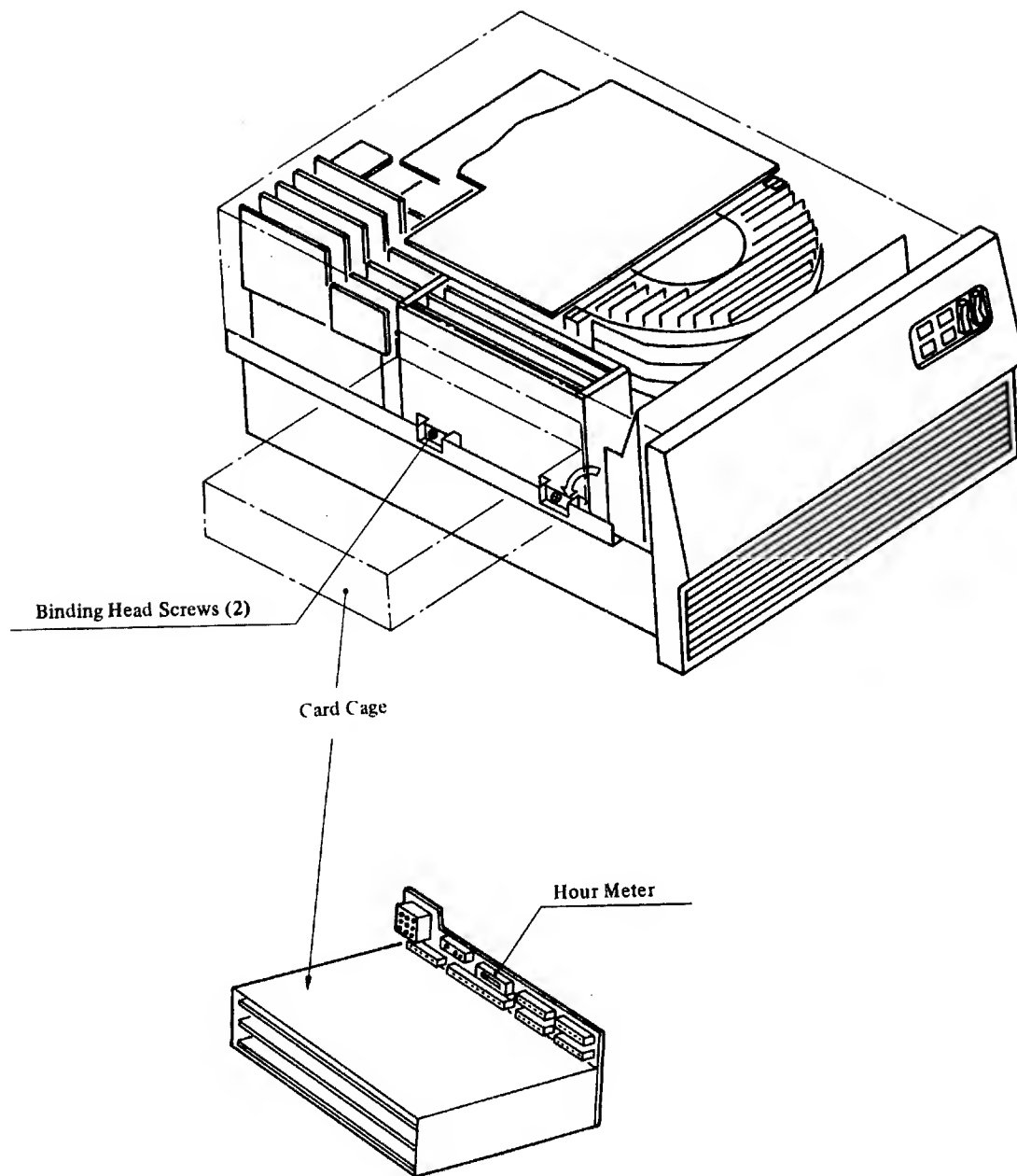
1. Remove 2 binder-head screws holding the card cage.
2. Lift the card cage vertically and rotate over the side.
3. Install the Hour Meter in the connector, as indicated in Figure 13.7-1.

Note: The arrow of the hour meter must be the same direction of the socket, and then if the indicator will fully change red, pull out this indicator and plug in again reversely.

### (2) Removal

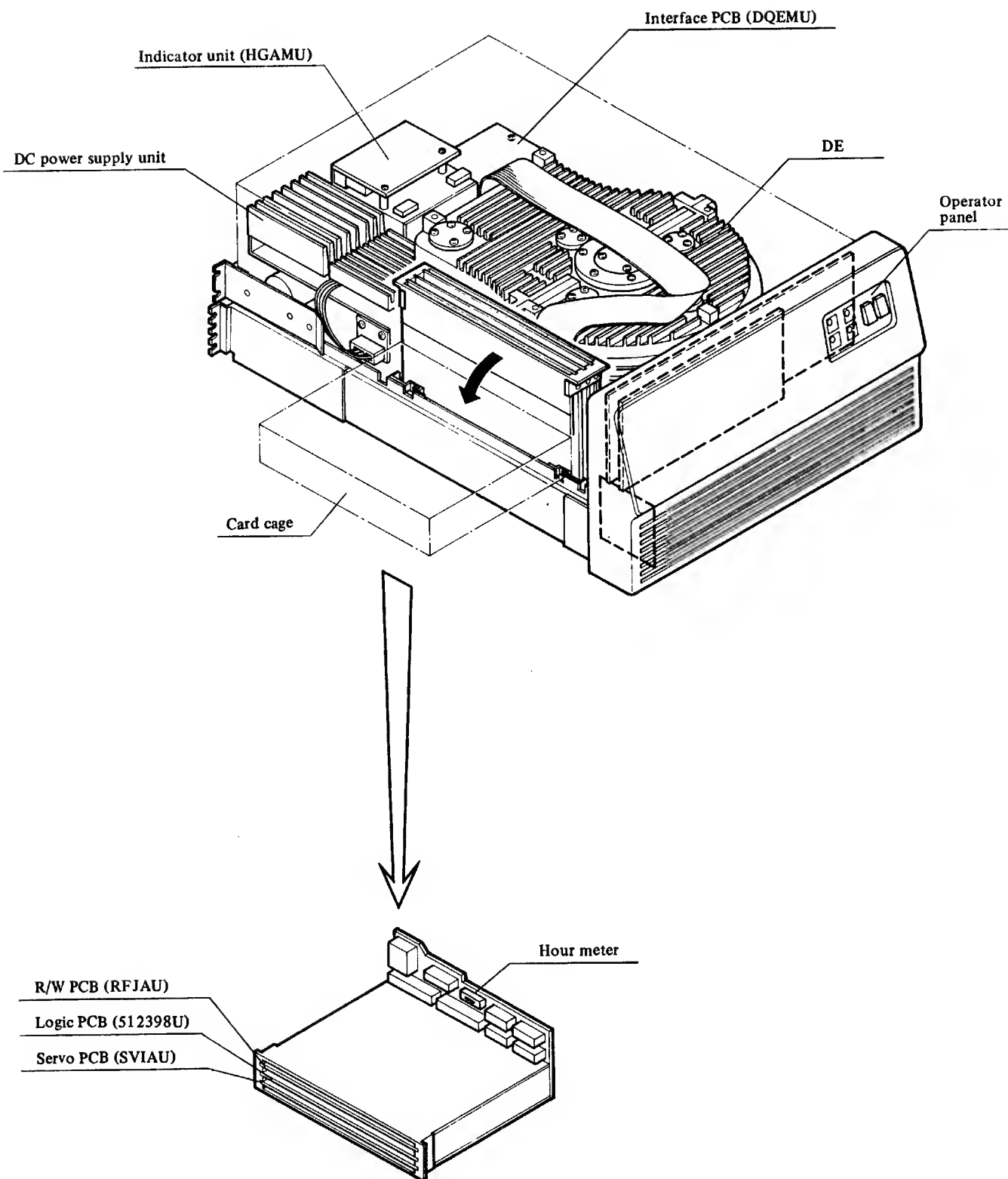
Follow, in reverse order, the instructions for installation.





(a) Early version

Figure 13.7-1 Installation of Hour Meter



(b) Current version

Figure 13.7-1 - Continued

## 13.8 DUAL CHANNEL OPTION

### (1) Installation

1. Remove the TVHMu PCB. (Refer to 13.2-(1)) (Early version only)
2. If standoffs are not already in place on interface PCB (DQEMU), remove the 4 screws holding DQEMU and install 4 standoffs.
3. Disconnect CNP44, CNP45 and CNP62/46 cables.
4. Connect jumper cables (between the interface and dual channel PCBs) in the headers on the interface PCB (DQEMU).
5. Install dual channel PCB (DQFMU) on the 4 standoffs and secure with 4 screws.
6. Connect the other end of the jumper cables from DQEMU to CNP54, CNP55 and CNJ62 of the DQFMU PCB.
7. Connect cables CNP44, CNP45 and CNP62/46 to CNP57, CNP59 and CNJ56.
8. Install the TVHMu PCB (Refer to 13.2-(2)) (Early version only)

### (2) Removal

Follow, in reverse order, the instructions for installation.

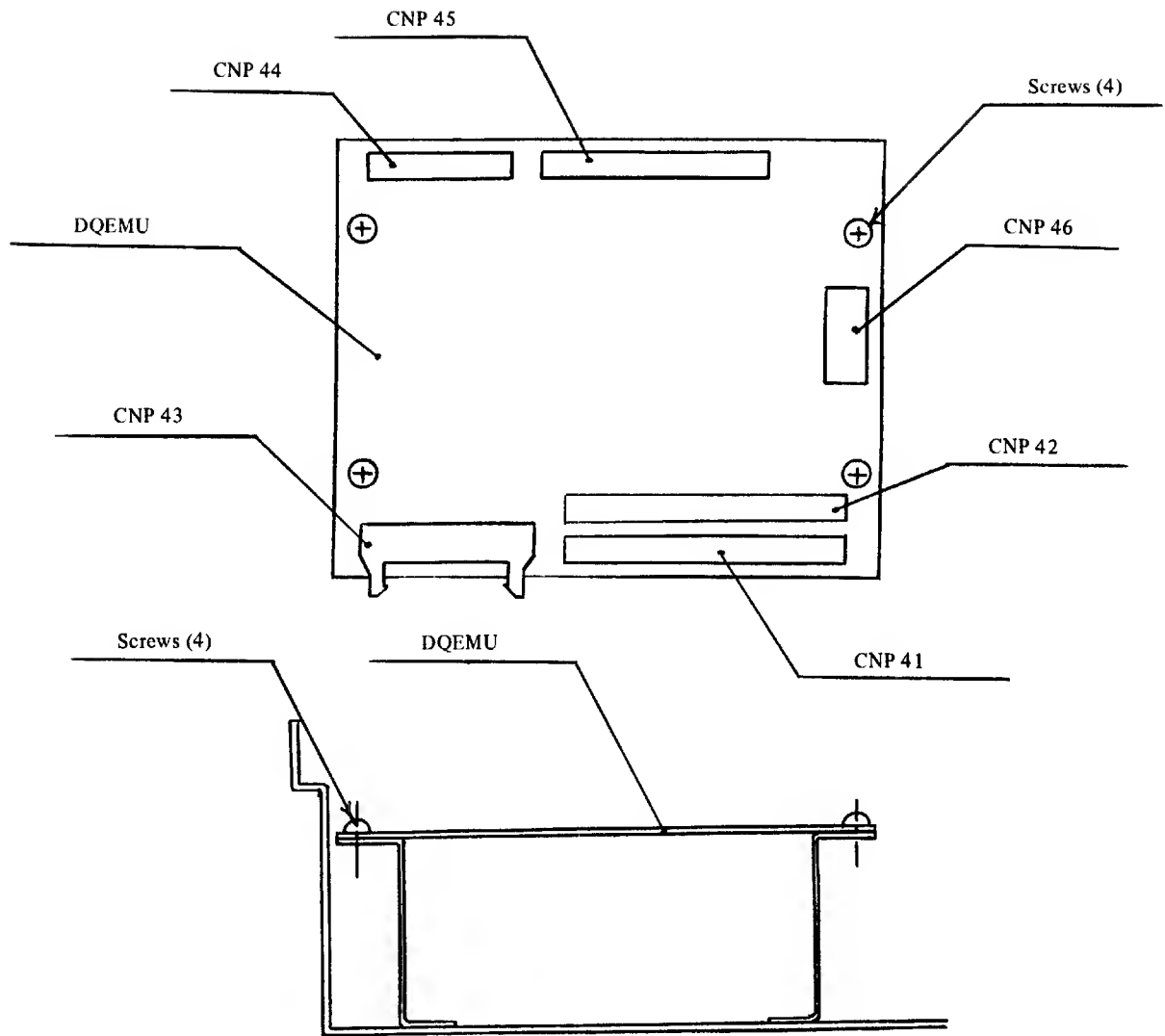


Figure 13.8-1 Installation of Dual Channel Option

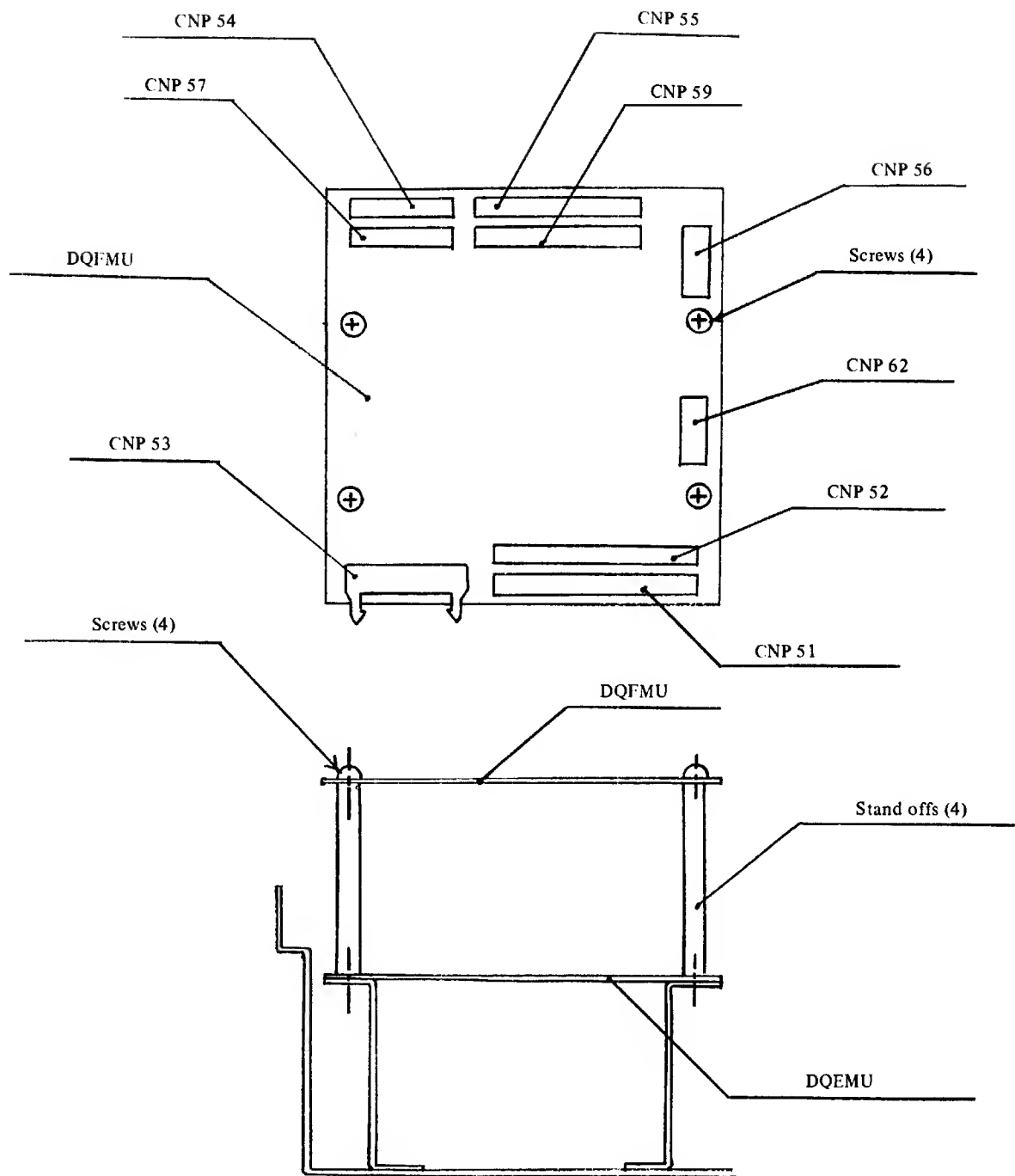


Figure 13.8-2 Installation of Dual Channel Option

## 13.9 DC POWER SUPPLY UNIT

### (1) Removal

1. Remove the PCB (HGAMU).
2. Remove connectors (CNP03, CNP61, CNP62, CNP64, CNP65, CNJ66) that go out from the power supply unit.
3. Remove the screws (2) which hold the power supply unit to the frame of the drive.
4. Carefully slide the power supply unit back and remove.
5. Remove the input AC power cable. (Refer to 13.10)

### (2) Installation

Follow, in reverse order, the procedure for DC power supply removal.

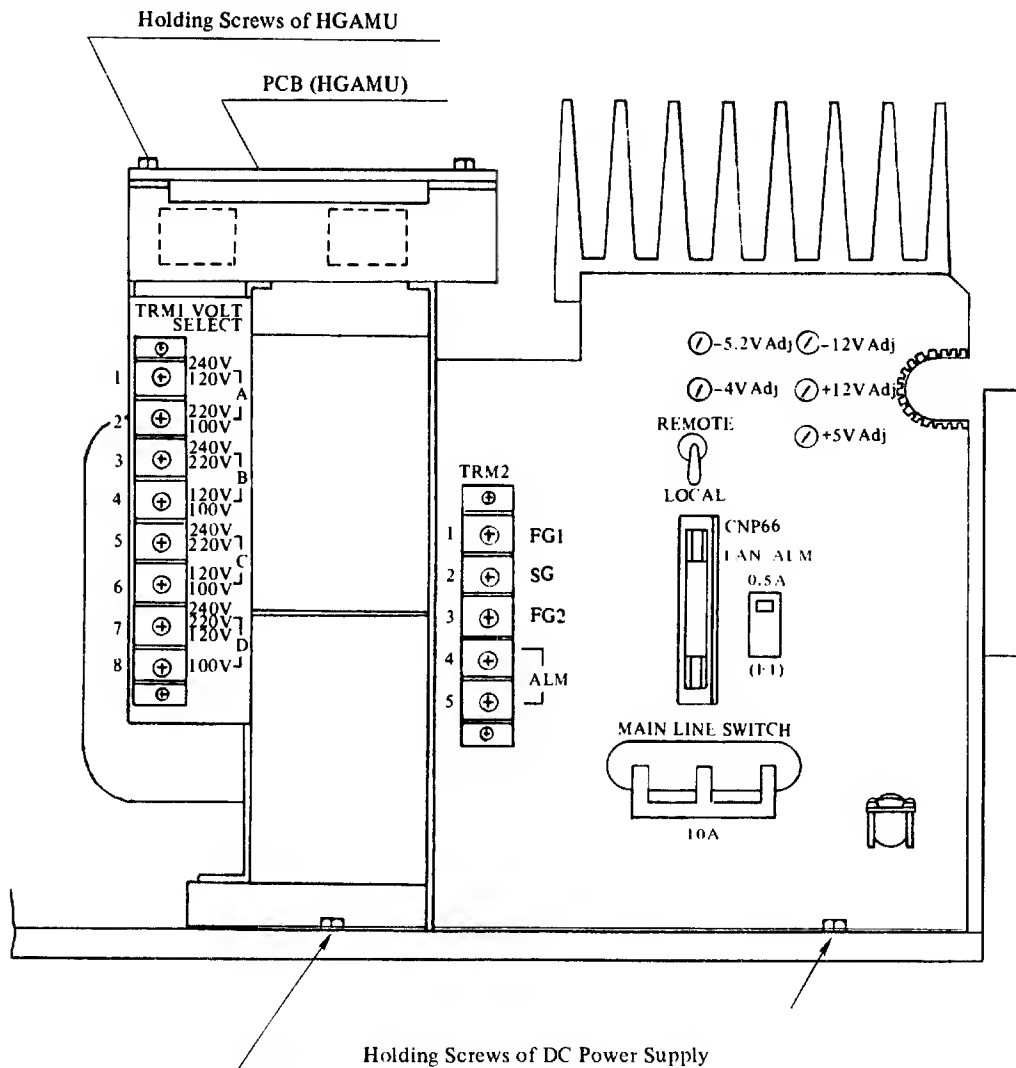


Figure 13.9-1

### (3) Adjustment of DC Voltages

Check the DC voltages at the check pins of Back Panel (BQGMU) using digital multimeter. The check pins' configuration is shown in Figure 13.9-2. If a DC voltage is out of the acceptable range of Table 13.9-1, readjust the corresponding RV shown in Figure 13.9-1.

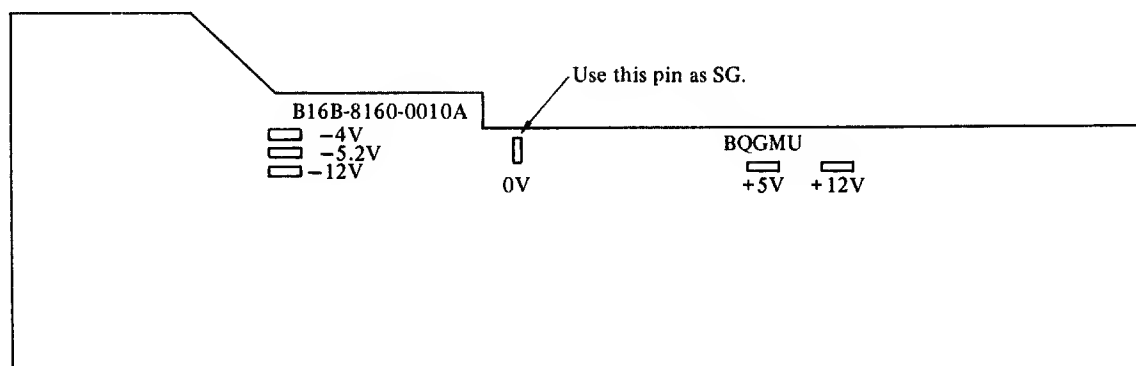


Figure 13.9-2 Top View of Back Panel

Table 13.9-1 Acceptable Range of DC Voltages

| DC Voltage | Acceptable Range |
|------------|------------------|
| +12 V      | 11.4 ~ 12.6 V    |
| +5 V       | 4.75 ~ 5.25 V    |
| -4 V       | -3.8 ~ -4.2 V    |
| -5.2 V     | -4.94 ~ -5.46 V  |
| -12 V      | -11.4 ~ -12.6 V  |

## 13.10 POWER CABLE

CAUTION: Check to be certain that the AC cable is not plugged in.

### (1) Removal

1. Remove the DC power supply (Refer to 13.9).
2. Remove the side cover by loosening 4 screws as shown in Figure 13.10-1.
3. Loosen cable clamp.
4. Remove terminals A and B (AC power) and terminal G (ground).
5. Remove the AC cable.

### (2) Installation

1. Follow, in reverse order, the procedure for power cable removal.

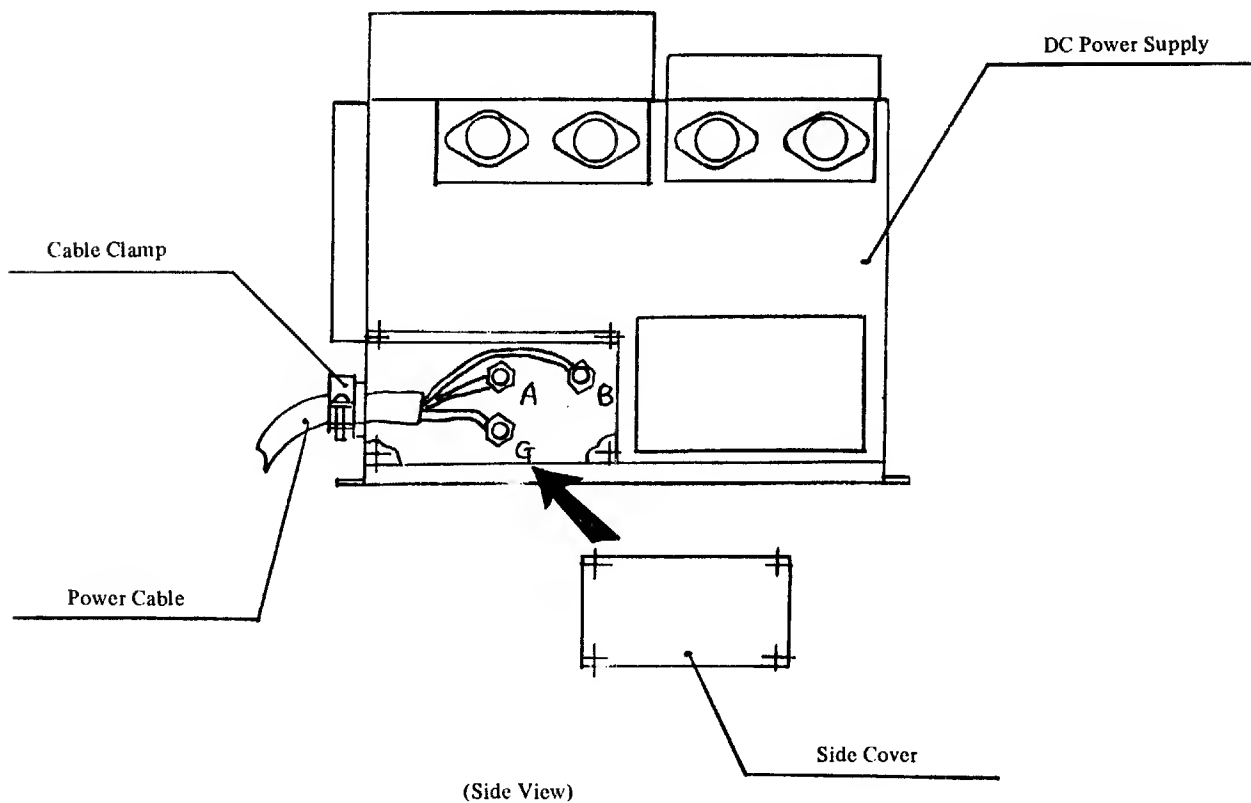


Figure 13.10-1 Installation of a Power Cable



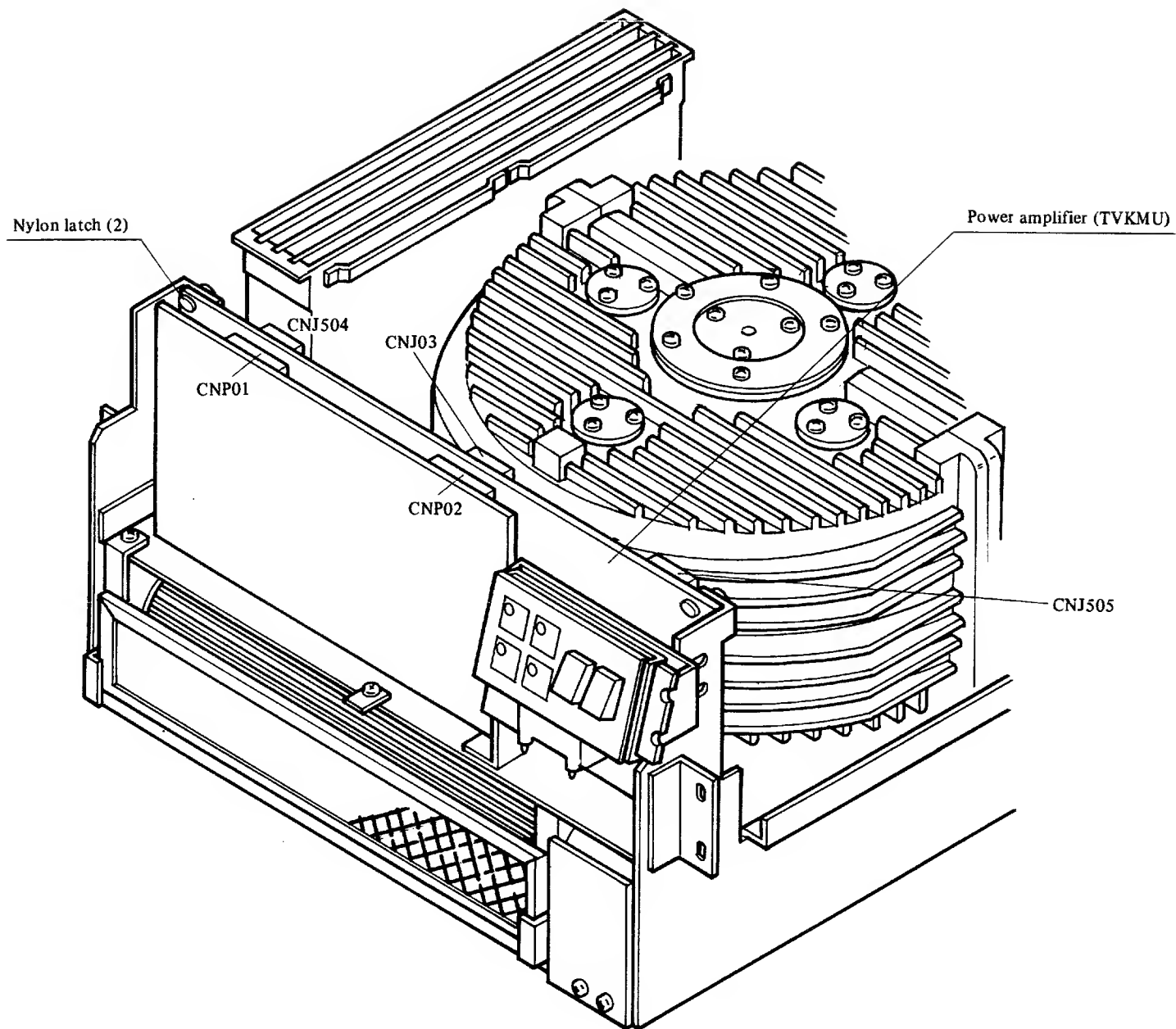


Figure 13.11-1 Power amplifier replacement

## 14.1 GUIDE TO PCBs AND LOGIC DIAGRAMS (SCHEMATICS)

Circuit diagrams contain input and output signal names (mnemonics), coordinate locations of ICs, input origins, destination coordinates of output signals, IC pin numbers and IC types. Figure 14.1-1 shows how to read circuit diagrams.

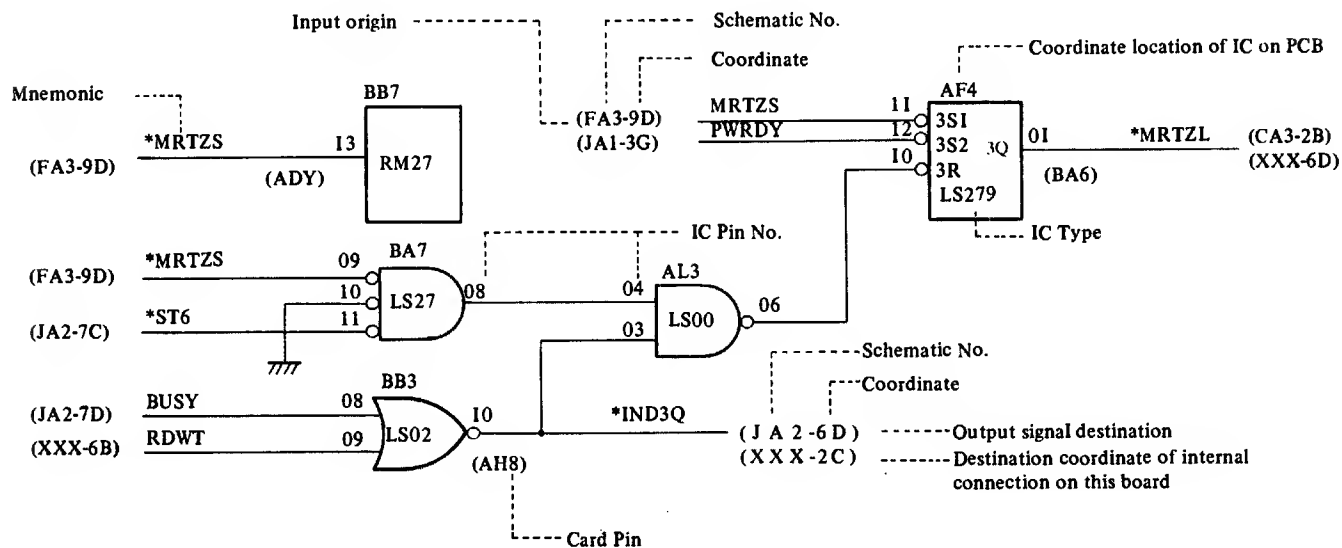


Figure 14.1-1 Logic Symbols

Figure 14.1-2 shows the IC location of PCB 512398.

Figure 14.1-3 shows the pin numbering of PCB.

Figure 14.1-4 shows the pin numbering of Back Panel.

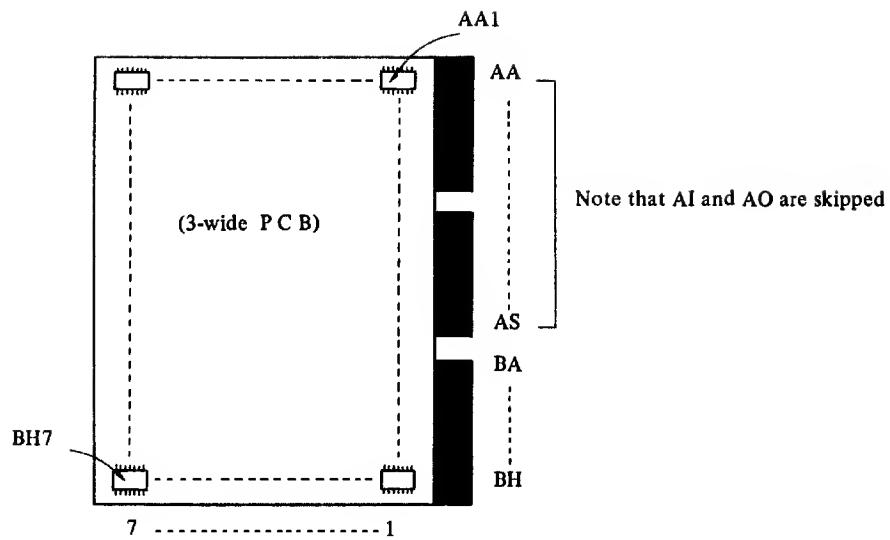


Figure 14.1-2 IC Location

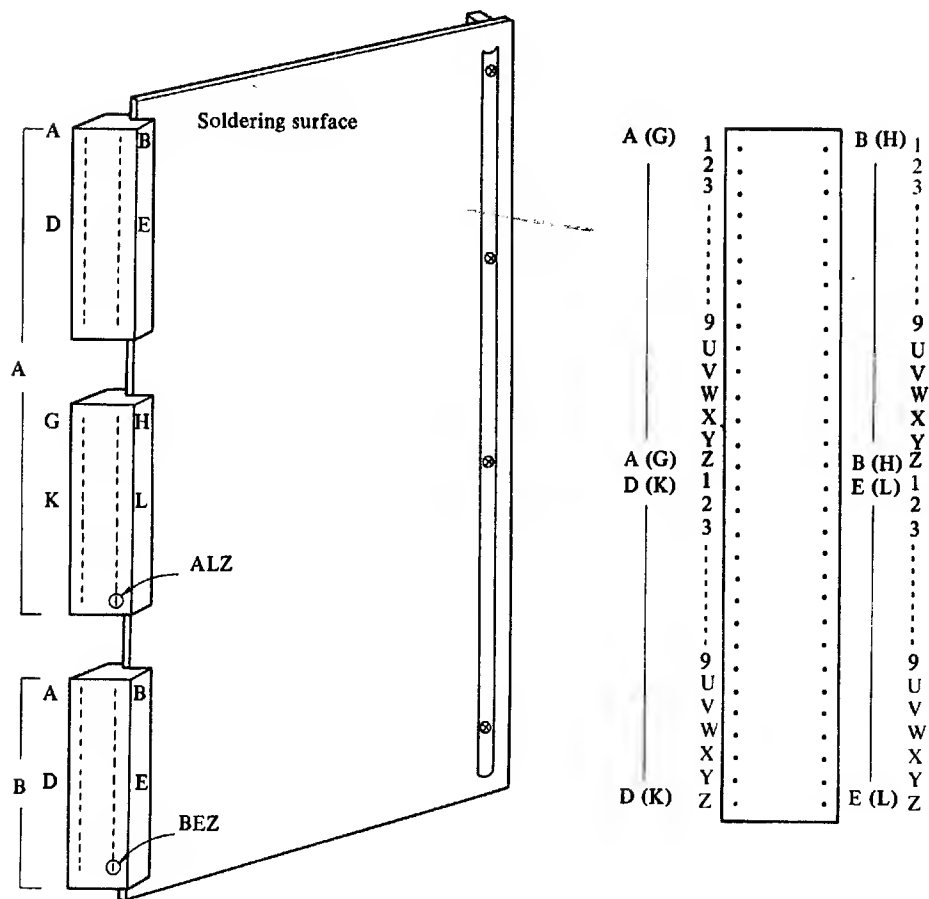


Figure 14.1-3 PCB Pin Numbering

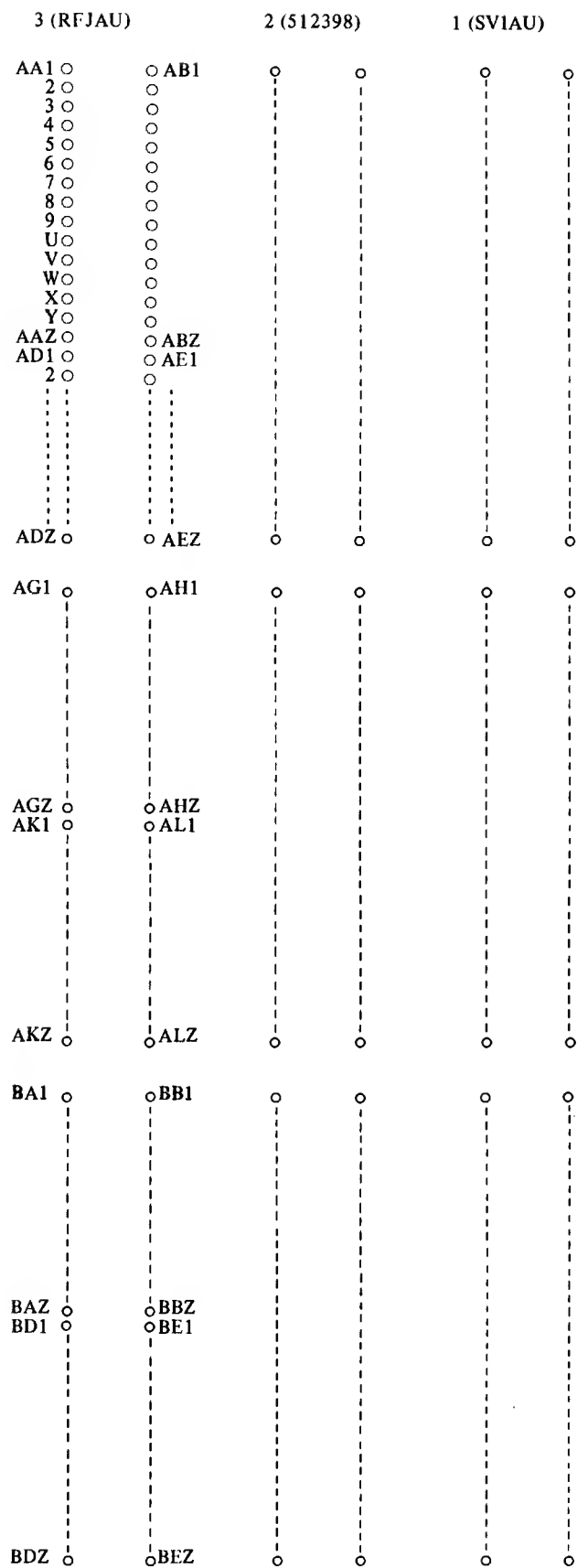


Figure 14.1-4 Back Panel Pin Numbering (Bottom View)

## 14.2 ADJUSTMENT OF SERVO CIRCUIT

### (1) Introduction

The following flow chart shows how to adjust and test the servo circuit.

If none of variable resistors have been adjusted, both "Static Adjustment" and "Dynamic Adjustment" are necessary. After changing the DE or PCB SVIAU, only "Dynamic Adjustment" is needed, that is, RVs 1, 2, 3, 10 and 13 are needed to be adjusted.

Prior to the "Static Adjustment", stop the spindle, power off and pull out connector CNP504 (Output cable of Power Amplifier to the rotary actuator).

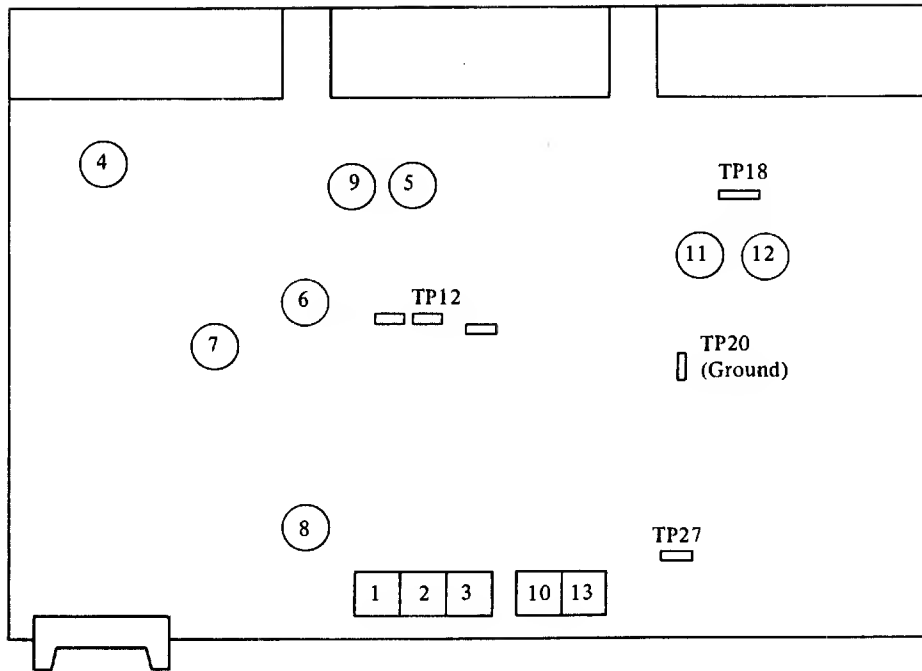


Figure 14.2-1 RVs and TPs on PCB SVIAU/01

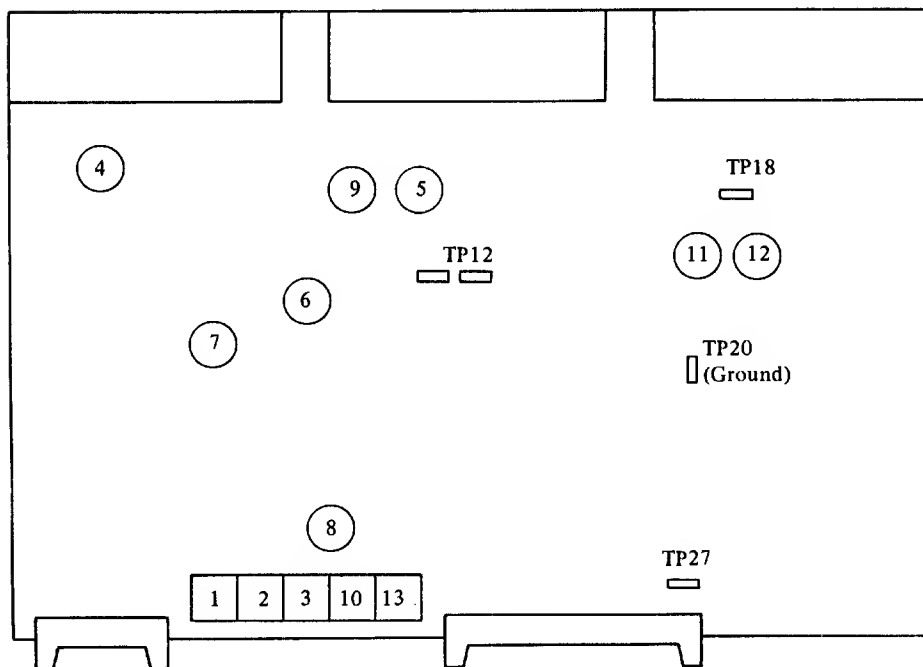


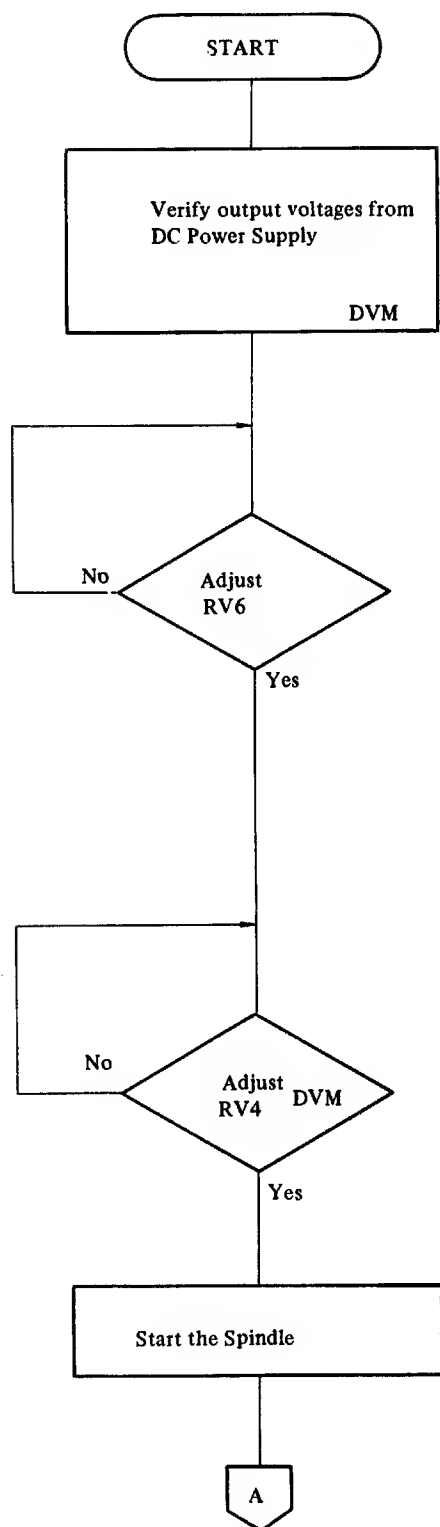
Figure 14.2-2 RVs and TPs on PCB SVIAU/02

Table 14.2-1 Function of RVs

| RV No. | Function/Adjustment                          | Sealed <sup>*</sup> |
|--------|----------------------------------------------|---------------------|
| 1      | AGC Amplifier gain                           | No                  |
| 2      | Over - shooting                              | No                  |
| 3      | Access time                                  | No                  |
| 4      | -4V                                          | Yes                 |
| 5      | Offset voltage of the desired velocity curve | Yes                 |
| 6      | VCO free - running frequency                 | Yes                 |
| 7      | Timer - Gate pulse width                     | Yes                 |
| 8      | Sync. - Gate timing                          | Yes                 |
| 9      | D/A Converter gain                           | Yes                 |
| 10     | Velocity offset                              | No                  |
| 11     | Access Time Out pulse width                  | Yes                 |
| 12     | Track Following Timer pulse width            | Yes                 |
| 13     | Settling in Fine Control                     | No                  |

\* Do not touch the sealed RVs unless adjustments are required.

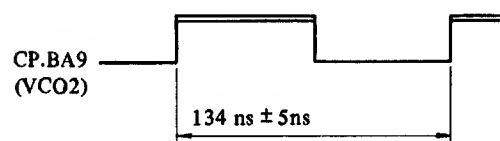
## (2) STATIC ADJUSTMENT



The card cage must be opened (lifted and rotated 90°) to expose the Back Panel.

+12V; CP.AA1  
+5V; CP.AAZ  
-5.2V; CP.ABZ  
-12V; CP.AEZ  
(Ground; CP.AD2)

VCO Free-Running frequency  
Connect CP.AEW to ADW (Ground)



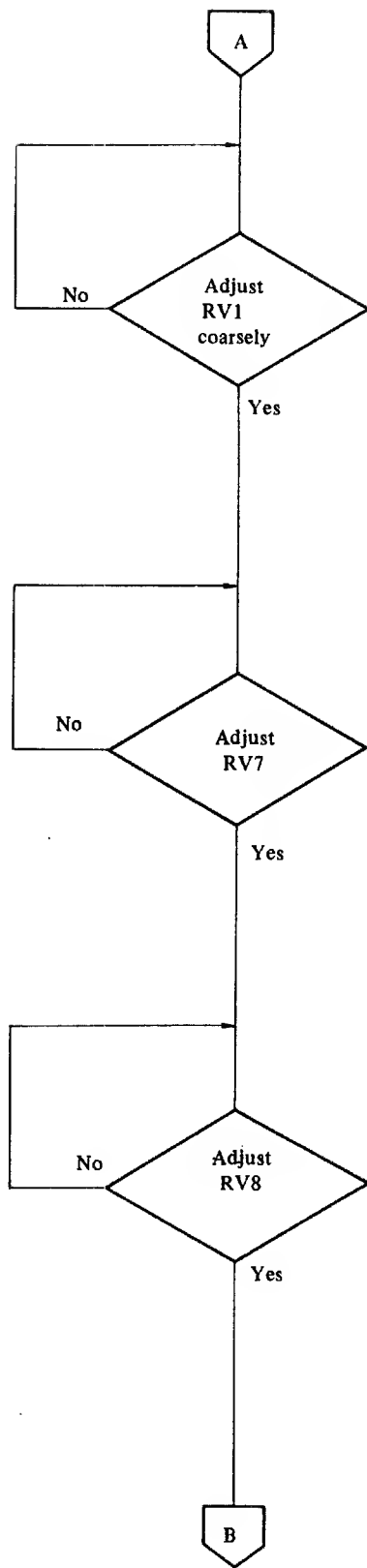
After the adjustment, disconnect CP.AEW from Ground.

CP.AA6; -4V ±0.1V  
CP.AA5; +6V ±0.1V  
(Ground; CP.AD2)

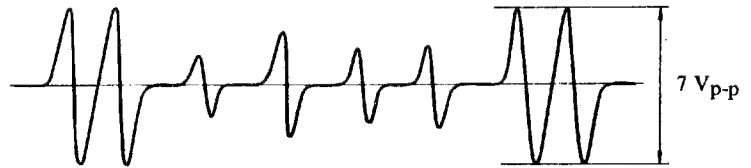
Turn on the Start/Stop switch on the operator panel and check that the spindle is rotating.

Figure 14.2-3 Static Adjustment of Servo Circuit (Sheet 1 of 5)

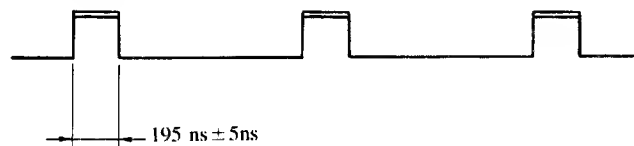




CP. AA4 (CRAMP)



CP. AD5 (TMGT)



Sync. Gate timing diagram

PCB 512398 CP.AH2 (\*GSYNC)  
and CP.AE7 (SYNCG)

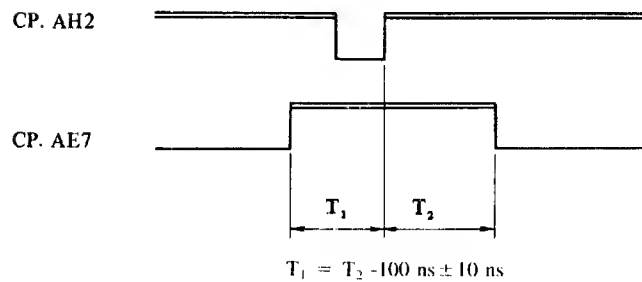


Figure 14.2-3 Static Adjustment of Servo Circuit (Sheet 2 of 5)

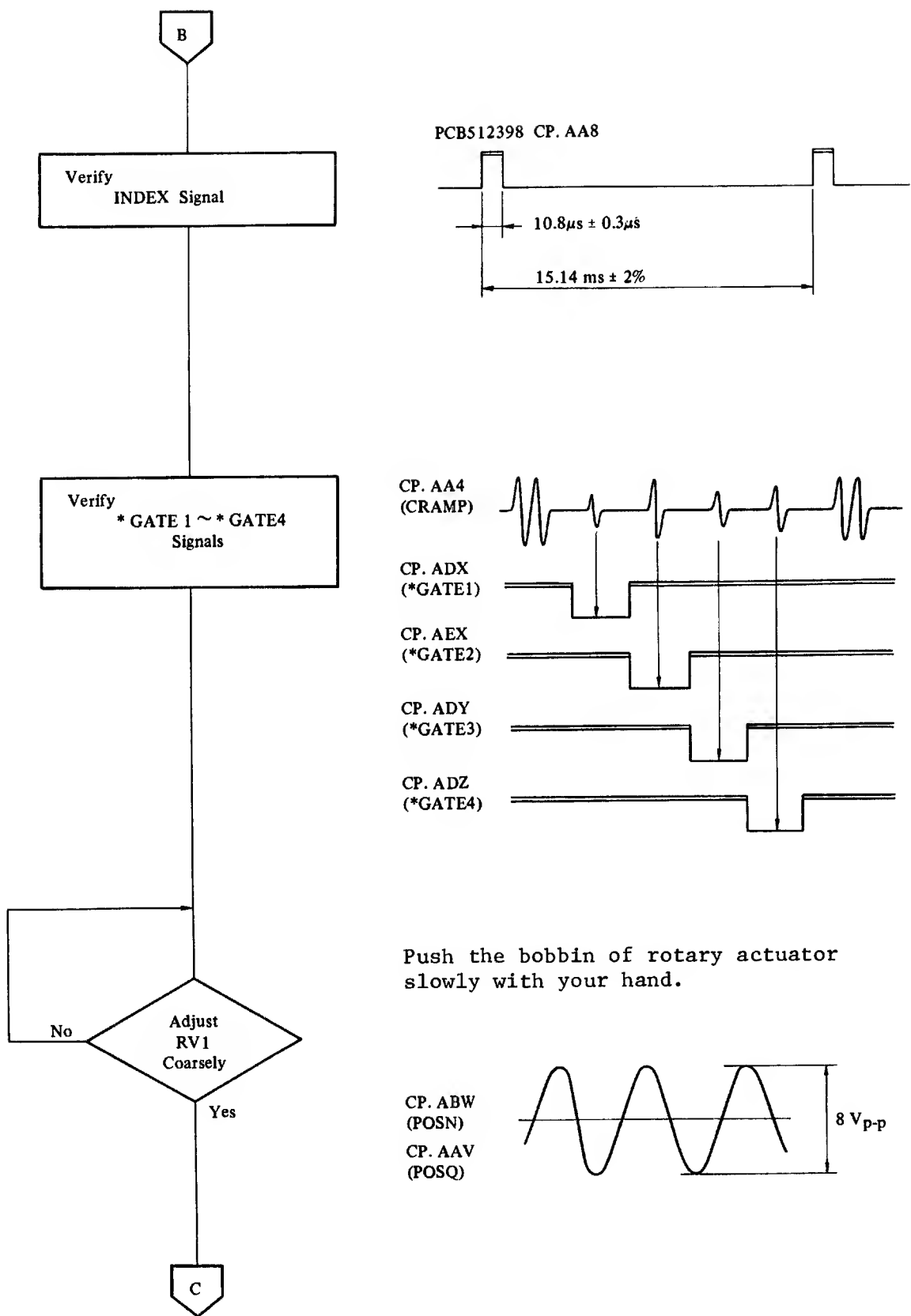
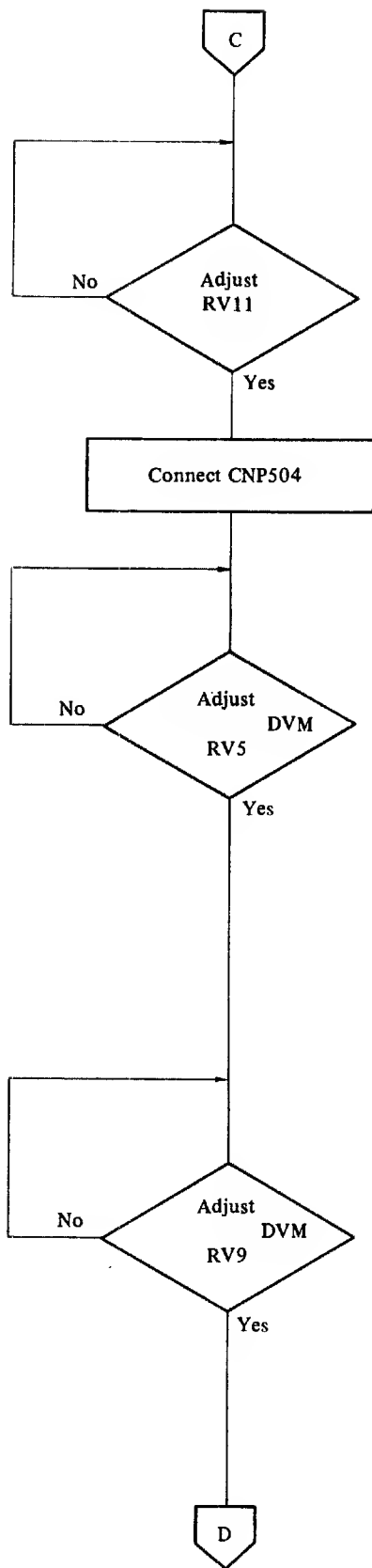
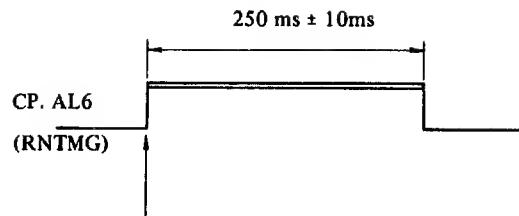


Figure 14.2-3 Static Adjustment of Servo Circuit (Sheet 3 of 5)



Access Time Out



Turn on the MRTZ switch on the PCB HGAMU.

Connect the output cable  
of Power Amp. to the  
Rotary actuator.

Offset voltage of the desired velocity  
curve

TP12, CP.AB3; 0V ±10mV  
(FG)

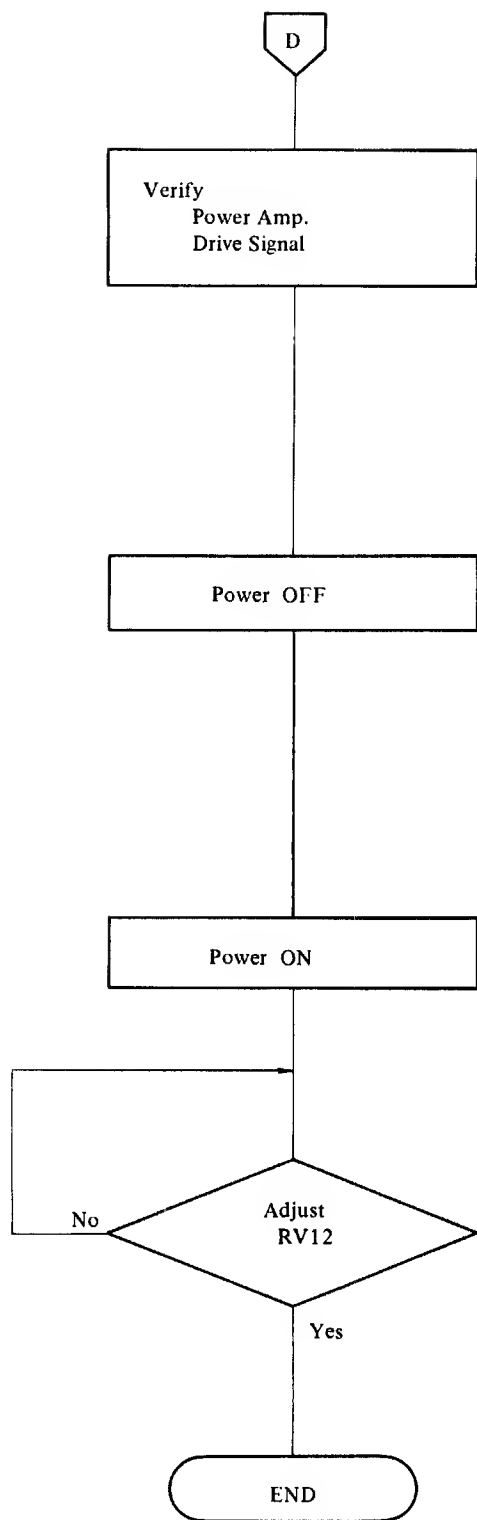
When GD1 ~ GD128 are all inactive.

Digital to analog converter gain

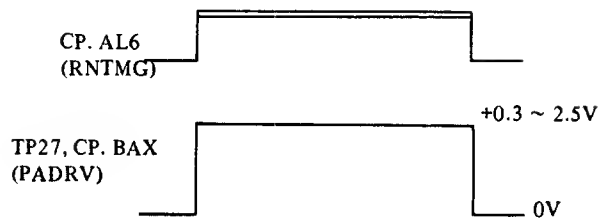
TP12, CP.AB3; +6V ±0.1V  
(FG)

When the difference register  
contains a value greater  
than 144.

Figure 14.2-3 Static Adjustment of Servo Circuit (Sheet 4 of 5)

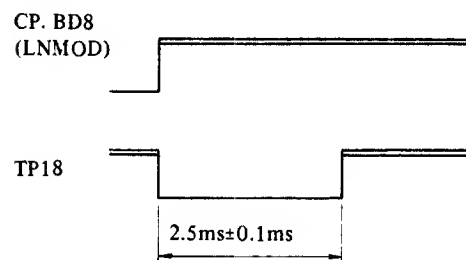


Turn on the MRTZ switch on the PCB HGAMU.



Turn on the MRTZ switch on the PCB HGAMU.

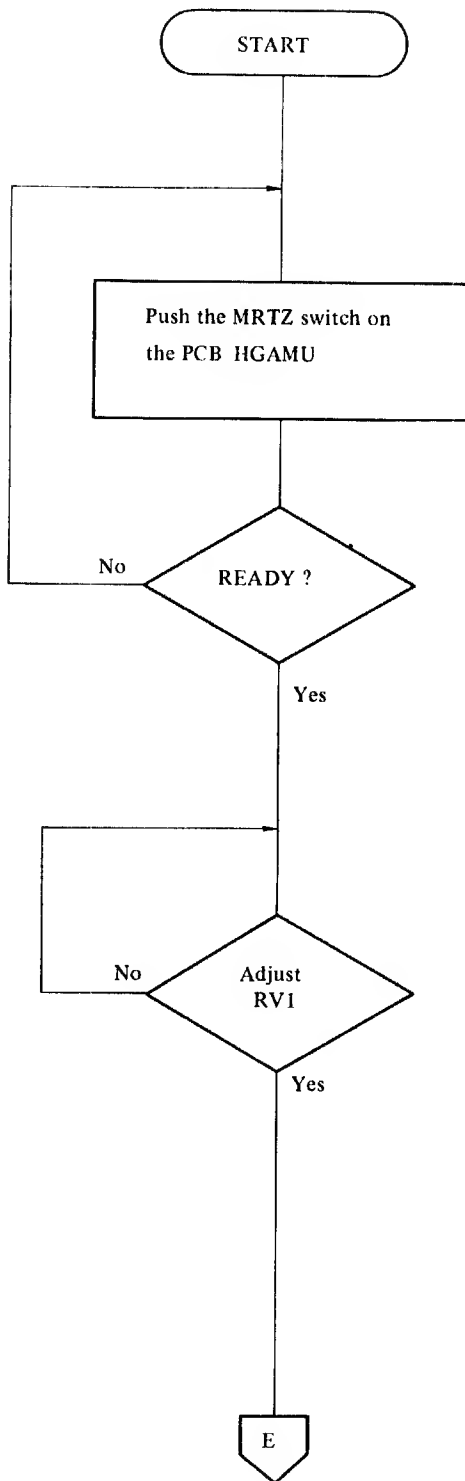
Track following Timer pulse width



Adjust RV3 by trial and error until the READY lamp light after RTZ operation.

Figure 14.2-3 Static Adjustment of Servo Circuit (Sheet 5 of 5)

### (3) DYNAMIC ADJUSTMENT



Adjust RV3 by trial and error until the READY lamp on the operator panel light after RTZ operation.

Performing RTZ operation from cylinder 841 repetitively, adjust RV1 as follows.

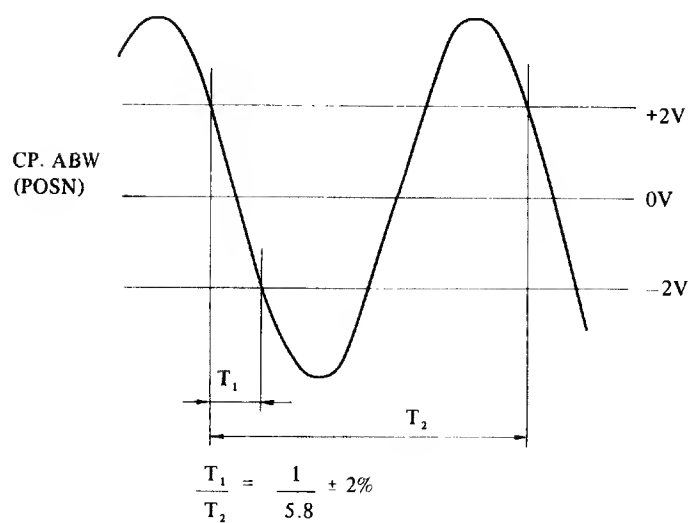


Figure 14.2-4 Dynamic Adjustment of Servo Circuit (Sheet 1 of 3)

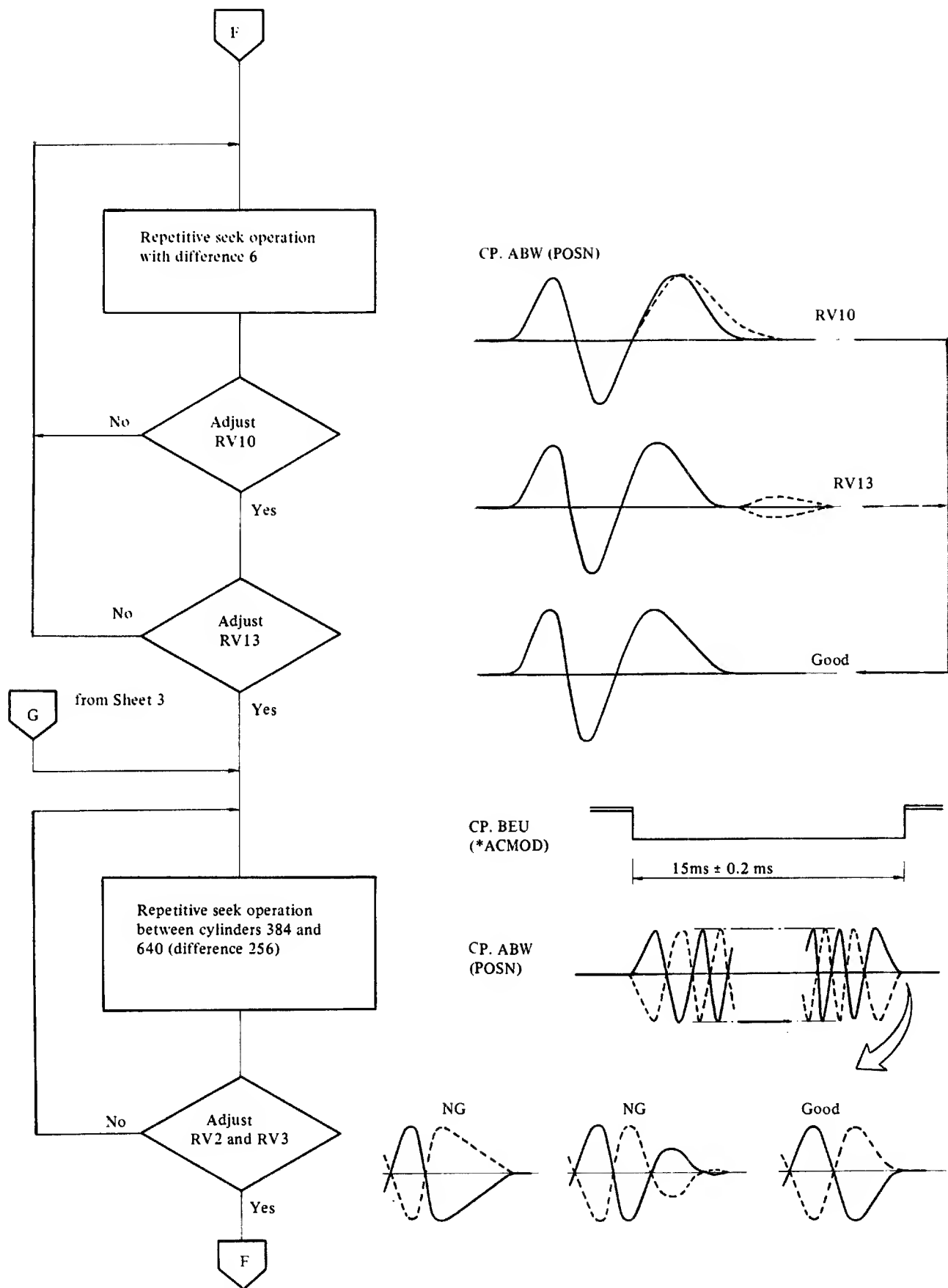
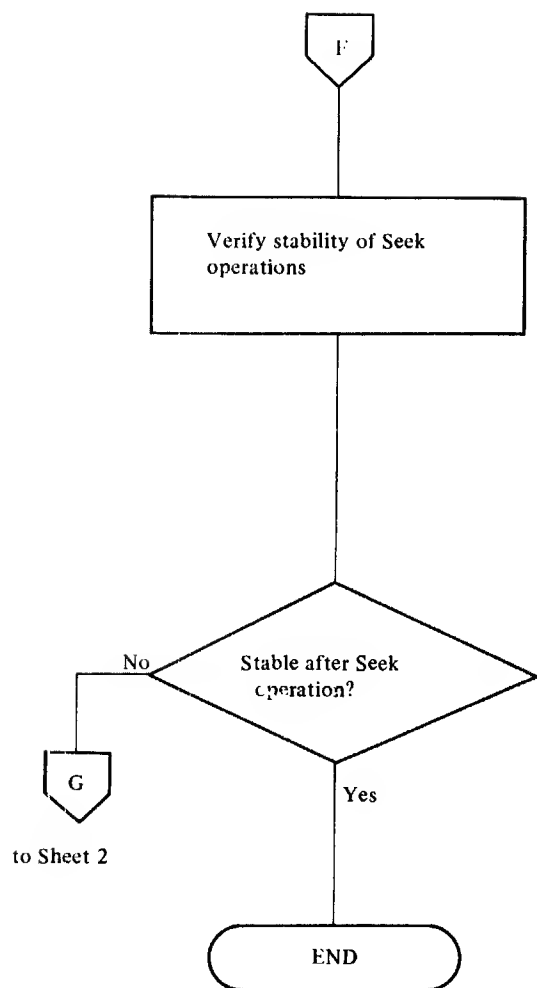


Figure 14.2-4 Dynamic Adjustment of Servo Circuit (Sheet 2 of 3)



Verify stability and vibration while performing seek operations by varying seek distance and time interval.

CP.AL3 (FNPOS)

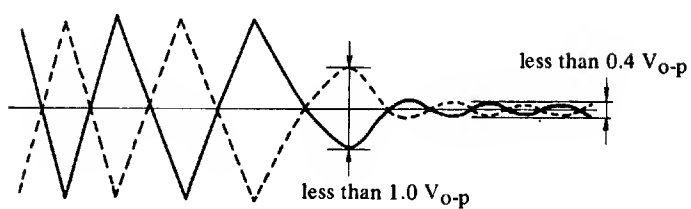


Figure 14.2-4 Dynamic Adjustment of Servo Circuit (Sheet 3 of 3)

### 14.3 ADJUSTMENT OF READ/WRITE CIRCUIT

The following describes how to adjust and test the Read/Write circuit in case none of variable resistors have been adjusted.

The card cage must be opened (lifted and rotated 90°) to expose the Back Panel.

PCB RFJAU must be inserted in Extender Unit.

Refer to Table 14.3-1 and Figure 14.3-1 for monitor point and location.

Table 14.3-1 Variable Resistors in Read/Write Circuit

| Item                   | RV No. | Test point                 | Specification |
|------------------------|--------|----------------------------|---------------|
| -5.2V (DC Voltage)     | RV1    | AB2<br>(or W3)             | -5.2V±0.2V    |
| +6V (DC Voltage)       | RV5    | W15                        | +6V±0.2V      |
| Balance of Read Signal | RV2    | W7<br>W8<br>(ADX)<br>(AEX) | Refer to (1)  |
| Write Current          | RV3    | W1<br>W2                   | Refer to (2)  |
| Jitter of Read Signal  | RV4    | W49                        | Refer to (3)  |



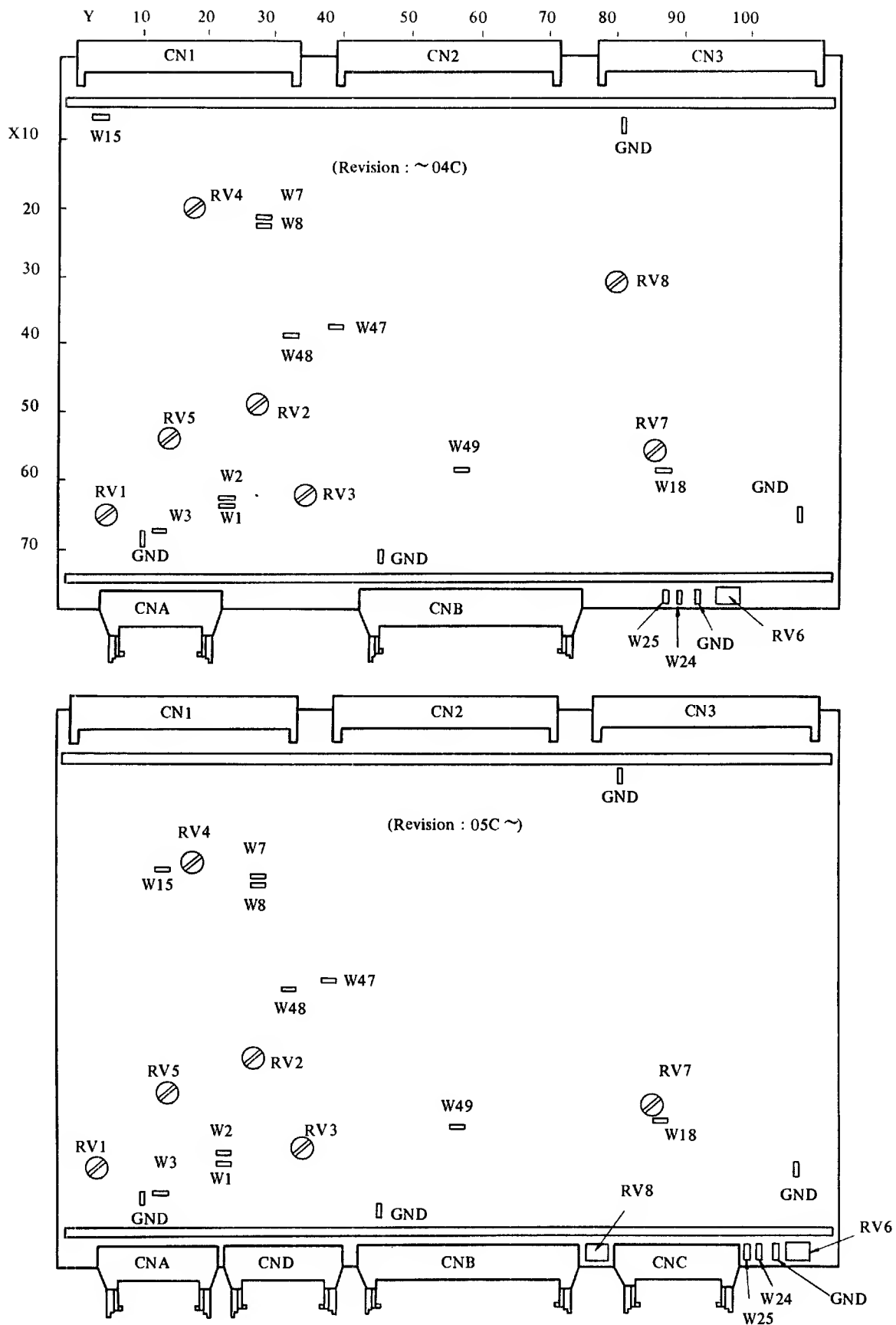


Figure 14.3-1 Variable Resistors on PCB RFJAU

(1) Balance of Read Signal (RV2)

Read the data recorded in Variable Sector Format on Cylinder 00 and Head 01, and adjust RV2 so that the read signal matches Figure 14.3-2.

If the data is recorded in Sector Format, the AMGCL signal is clamped low and the Differential Output continues  $2.6 V_{p-p} \pm 10\%$ .

Verify that, this balanced waveform is maintained on Cylinder 256, 512 and 841 for Head 00 and 01.

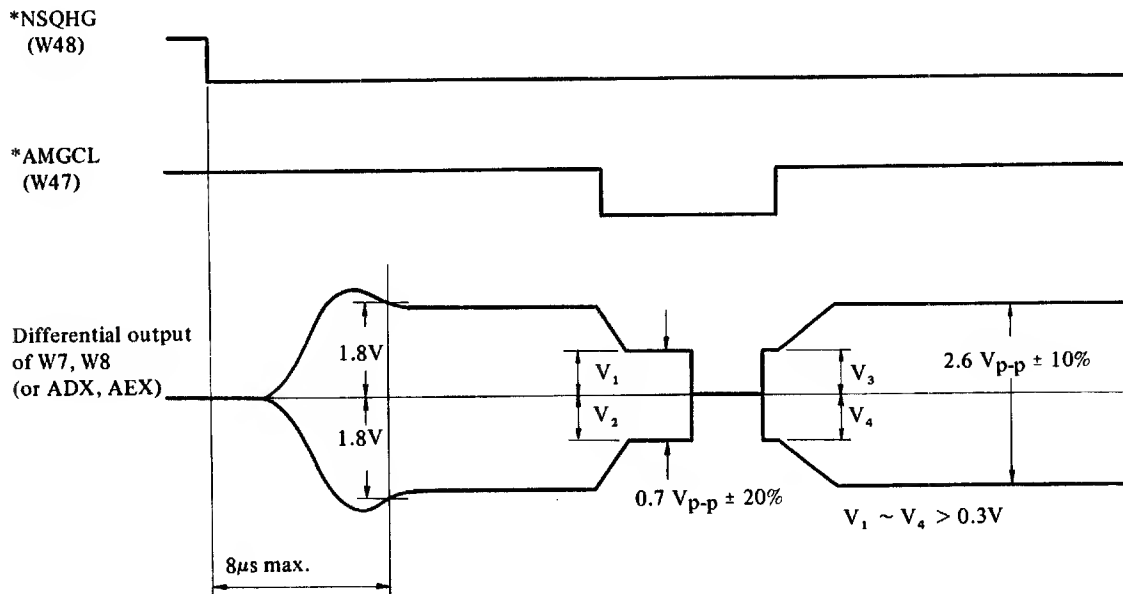


Figure 14.3-2 Balance of Read Signal

(2) Write current (RV3)

Adjust RV3 so that the differential output voltage  $V_5$  (W1 and W2) is  $400 \text{ mV} \pm 20 \text{ mV}$  while writing any data on Cylinder 00 Head 01 (Refer to Figure 14.3-3). Verify that, the voltage is  $500 \text{ mV} \pm 50 \text{ mV}$  on Cylinder 00 Head 00.

For Fixed Head Option, verify that the voltage is  $800 \text{ mV} \pm 80 \text{ mV}$  at Cylinder 896 Head 00 and is  $900 \text{ mV} \pm 100 \text{ mV}$  at Cylinder 897 Head 00 while writing any data.

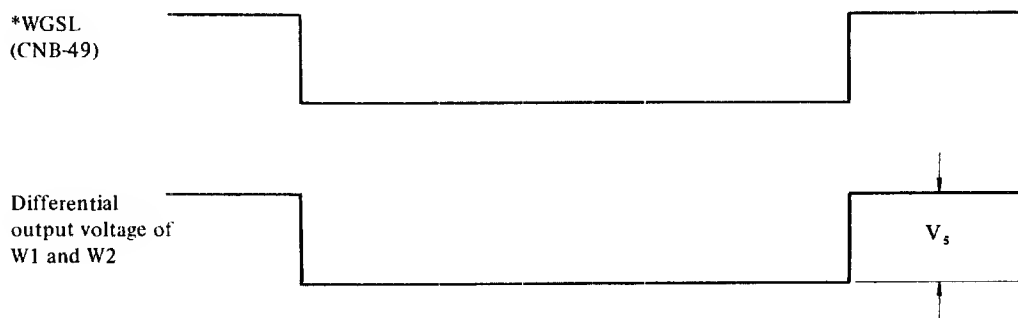


Figure 14.3-3 Write Current Adjustment

(3) Jitter of Read Signal (RV4)

Read the data pattern of "AAAA --- AA", recorded on Cylinder 00 and Head 00.

Adjust RV4 to minimize the jitter at the negative-going edge of the pulses as shown in Figure 14.3-4.

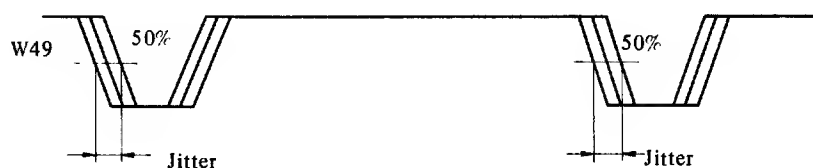


Figure 14.3-4 Jitter of Read Signal Adjustment

#### 14.4 ADJUSTMENT OF VFO CIRCUIT

The following describes how to adjust and test the VFO (Modulator and Demodulator) circuit (PCB RFJAU) in case none of variable resistors have been adjusted. Refer to Table 14.4-1 and Figure 14.3-1 for monitor point and location.

Table 14.4-1 Variable Resistors in VFO Circuit

| Item                       | RV No. | Test point      | Specification |
|----------------------------|--------|-----------------|---------------|
| VCO Free-running Frequency | RV8    | BA9<br>(or W24) | Refer to (1)  |
| Reference Pulse Width      | RV7    | W18             | Refer to (2)  |
| Phase Adjustment           | RV6    | W24<br>W25      | Refer to (3)  |

##### (1) VCO Free-running Frequency (RV8)

Connect CNB-24 (Connector B, Pin 24) to ground, and adjust RV8 so that the pulse period or frequency of BA9 or W24 matches Figure 14.4-1.

Disconnect the cable between CNB-24 and ground after adjust or confirm the item.

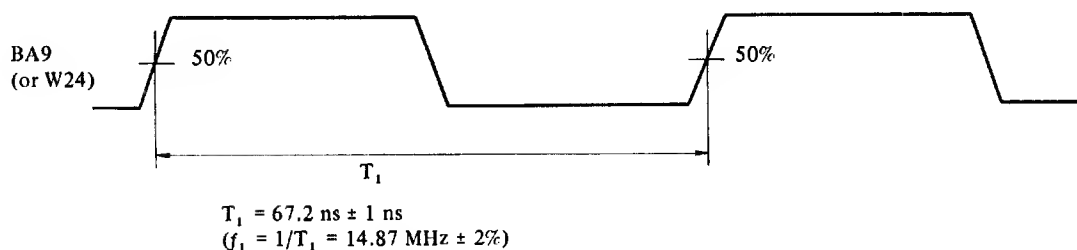


Figure 14.4-1 VCO Free-running Frequency Adjustment

(2) Reference Pulse width (RV7)

Read or write any data, and adjust RV7 so that the pulse width of W18 matches Figure 14.4-2.

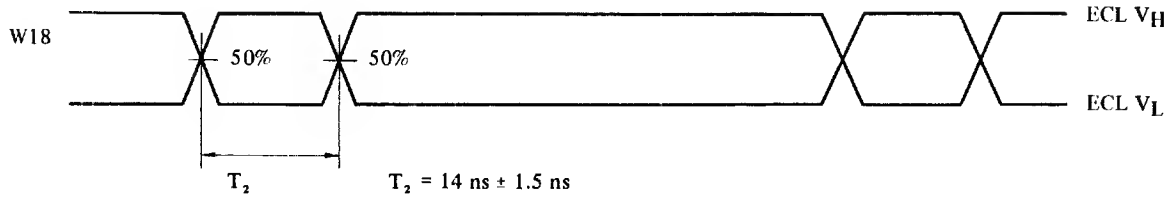


Figure 14.4-2 Reference Pulse width Adjustment

(3) Phase adjustment (RV6)

Read the data pattern of "FF...FF", and adjust RV6 so that the phase between W24 and W25 matches Figure 14.4-3.

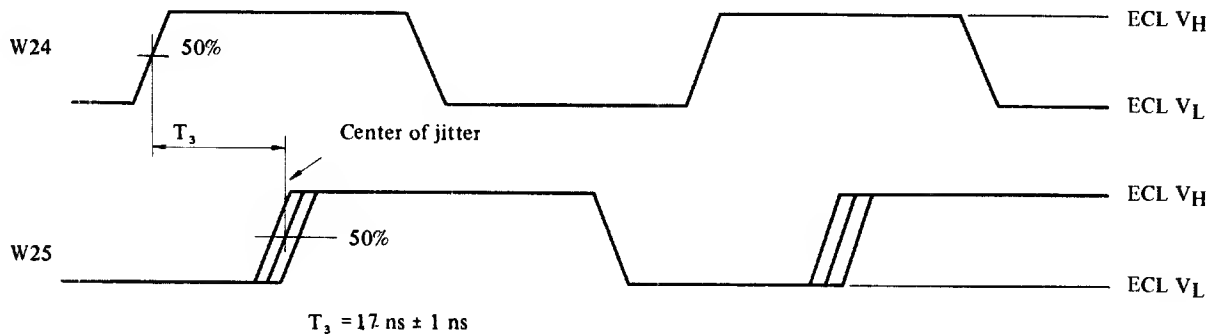


Figure 14.4-1 Phase Adjustment

## CHAPTER 15 TROUBLE SHOOTING

### 15.1 INTRODUCTION

This section contains trouble shooting flow charts according to the error status on the disk unit and control unit.

It is recommended that before any operations, maintenance personnel read carefully Chapter 12 Maintenance and fully understand the details of the procedures and tools required.

Inspect the following items before applying power to the unit.

- (1) Ensure that the AC line conditions satisfy the unit's requirements.
- (2) If the control unit does not utilize Pick/Hold power sequencing lines, select "Local" mode on the power supply unit.
- (3) Verify all connectors are inserted correctly.
- (4) If the unit is in daisy chain with another unit, make sure that the last unit has a line terminator (LTN) installed.
- (5) Verify that the rotary actuator is unlocked.
- (6) Ensure that the logical unit number (LUN) is selected properly and is assigned to only one unit.
- (7) In case of Hard sector mode (fixed sector length), ensure that the correct sector count is set on the PCB 512398.
- (8) Ensure that Tag 4/5, seek end status and response of unit ready are set correctly according to the system configuration.
- (9) Ensure that all PCB assemblies are firmly seated.

## 15.2 ERROR STATE

The disk unit and the control unit will issue the following statuses.

Table 15.2-1 Error Status

|            |                                                                                    |
|------------|------------------------------------------------------------------------------------|
| NOT READY  | Not Ready status indicates disk drive is not ready                                 |
| FAULT      | Fault status indicates a fault condition has occurred in the unit                  |
| SEEK ERROR | Seek Error status indicates a seek error has occurred in seek operation            |
| READ ERROR | Read Error status indicates a data error has occurred in read operation            |
| AM MISSING | AM Missing status indicates that AM (Address Mark) has not found in read operation |

Maintenance Personnel can see the unit status and error state on the Indicator Unit (HGAMU) and the Operator Panel. Refer to Section 3.7 for detailed unit status and error state, and how to know the error state by unit state indicators (colored LEDs), state indicators (7-segment LEDs) and state switch (Toggle Switch) mounted on the Indicator PCB.

The troubleshooting guide, Table 15.2-2, will help in locating a faulty sub-assembly. Use of the guide is as follows:

- (1) The Fault or Access Check LED must be lit, or the Unit Ready LED must be out. (These LED's are located on the Indicator PCA, HGAMU.) If none of these conditions exist, the drive is not in a fault state and the guide will be of no value.
- (2) The error status as defined by the LED's will be either Not Ready, Fault, or Seek Error (left side of Table 15.2-2).
- (3) Continuing to the right, the LED's also define the only valid switch position to observe the 7-Segment readouts (LP1 and LP2).
- (4) The hexadecimal number displayed is represented binarily in the guide. Thus, if the Fault LED is lit, switch position 0 is selected, and "04" is displayed, you have a Delta I Write Check.
- (5) The flow-charts for all Fault-type errors begin with Figure 15.4-2, as shown in the last column on the right. Looking at the starting points at the top of the pages, Delta I Write Check is found on Sheet 3 of 4.

Table 15.2-2 Error State

| Error Status | Indicator Unit (HGAMU)      |         |    |                      |         |         |    | Indicators on the Operator Panel |          |       | Error State                                                                                                                                                                                         | Figure    |        |
|--------------|-----------------------------|---------|----|----------------------|---------|---------|----|----------------------------------|----------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|
|              | Unit State Indicator (LEDs) |         |    | State Indicator Lamp |         |         |    |                                  |          |       |                                                                                                                                                                                                     |           |        |
|              |                             |         |    | State Switch         | Bit     | Bit     |    | Fault                            | Power on | Ready |                                                                                                                                                                                                     |           |        |
|              | 1 2 4 8                     | 1 2 4 8 |    |                      |         |         |    |                                  |          |       |                                                                                                                                                                                                     |           |        |
| Not Ready    | Off                         | -       | -  | -                    | - - - - | - - - - | 00 | -                                | Off      | Off   | Power Alarm<br>Hall Alarm<br>DE Sequence Check                                                                                                                                                      | Not Ready | 15.4-1 |
|              | Off                         | -       | -  | 2                    | - - - 1 | - - - - | 80 | -                                | -        | Off   |                                                                                                                                                                                                     |           |        |
|              | Off                         | -       | -  | 1                    | - - - - | 1 - - - | 01 | -                                | -        | Off   |                                                                                                                                                                                                     |           |        |
| Fault        | -                           | -       | On | 0                    | 1 - - - | - - - - | 10 | On                               | -        | -     | Index Check<br><br>Control Check<br><br>Multi Head Check<br><br>Head Short Check<br><br>Write Current On Read Check<br><br>Write Transition Check<br><br>Delta I Write Check<br><br>Servo Off-Track | 15.4-2    |        |
|              | -                           | -       | On | 0                    | - 1 - - | - - - - | 20 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
|              | -                           | -       | On | 0                    | - - 1 - | - - - - | 40 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
|              | -                           | -       | On | 0                    | - - - 1 | - - - - | 80 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
|              | -                           | -       | On | 0                    | - - - - | 1 - - - | 01 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
|              | -                           | -       | On | 0                    | - - - - | - 1 - - | 02 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
|              | -                           | -       | On | 0                    | - - - - | - - 1 - | 04 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
|              | -                           | -       | On | 0                    | - - - - | - - - 1 | 08 | On                               | -        | -     |                                                                                                                                                                                                     |           |        |
| Seek error   | -                           | On      | -  | 1                    | - 1 - - | - - - - | 20 | -                                | -        | -     | Access Timeout Check<br><br>Over Shoot Check                                                                                                                                                        | 15.4-3    |        |
|              | -                           | On      | -  | 1                    | - - 1 - | - - - - | 40 | -                                | -        | -     |                                                                                                                                                                                                     |           |        |
| Read error   | -                           | -       | -  | -                    | - - - - | - - - - | 00 | -                                | -        | -     | Read Error                                                                                                                                                                                          | 15.4-4    |        |
| AM Missing   | -                           | -       | -  | -                    | - - - - | - - - - | 00 | -                                | -        | -     | AM Missing                                                                                                                                                                                          | 15.4-5    |        |

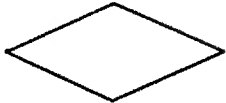


### 15.3 TROUBLE SHOOTING SYMBOL

The trouble shooting flow charts contain the procedures to pursue trouble causes starting from error status information.

The following conventions are provided to aid understanding the symbols used in the trouble shooting flow charts as shown in Table 15.3-1

Table 15.3-1 Symbol of Flow Chart

| Symbol                                                                                   | Description                                                          |
|------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
|         | Terminal.<br>Starting point of the trouble.                          |
| <br>( ) | Decision, go ahead according with YES or NO. (Reference test point.) |
|        | Connector, go ahead same-numbered symbol in the same sheet.          |
|       | Connector, go ahead same-numbered symbol in another sheet.           |
|       | Process.                                                             |

## 15.4 TROUBLE SHOOTING FLOW CHART

In this paragraph, the following charts are provided.

Figure 15.4-1 Not Ready

Figure 15.4-2 Fault

Figure 15.4-3 Seek Error

Figure 15.4-4 Read Error

Figure 15.4-5 AM Missing (for only Soft Sector Mode)

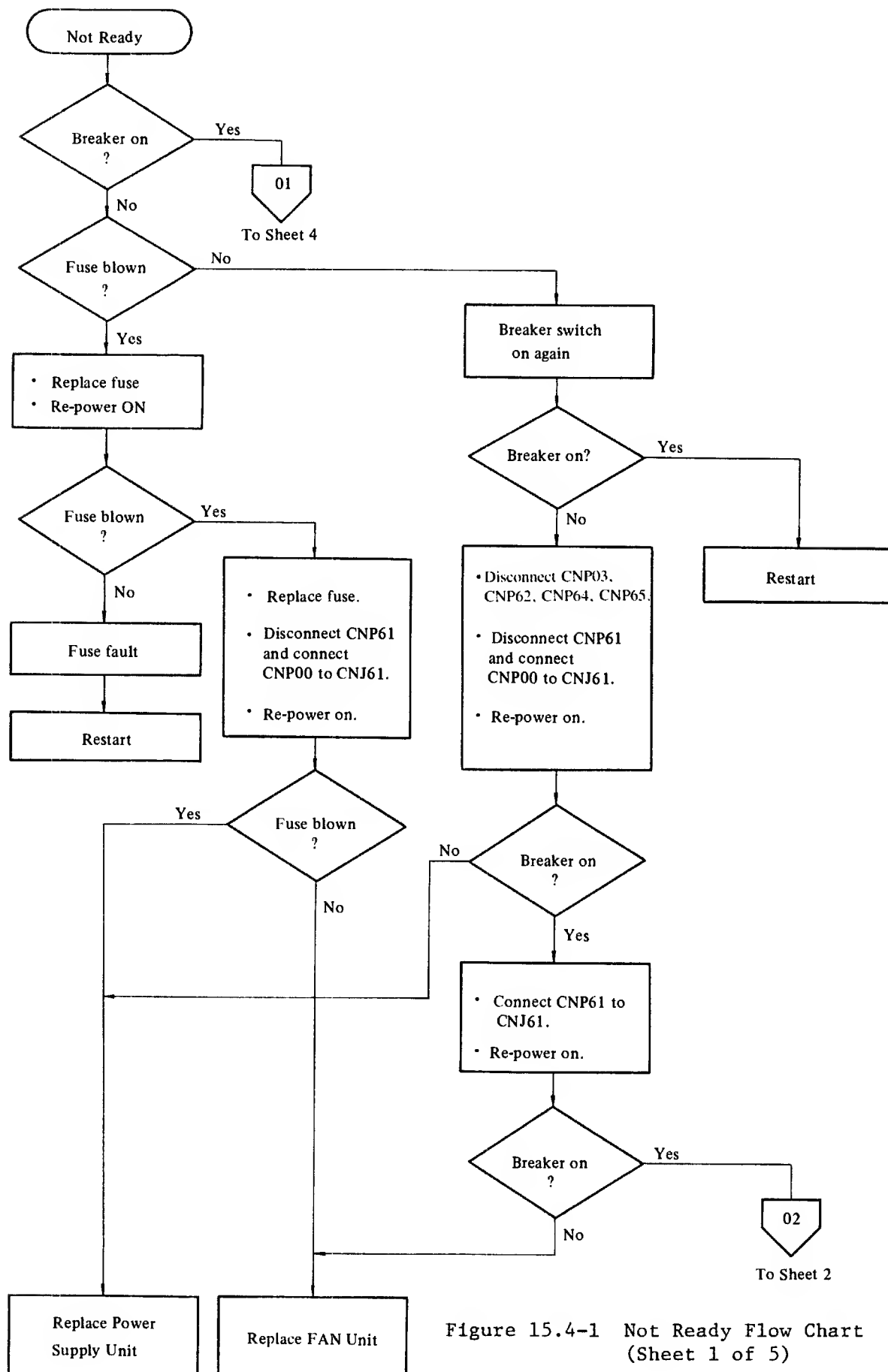


Figure 15.4-1 Not Ready Flow Chart  
(Sheet 1 of 5)

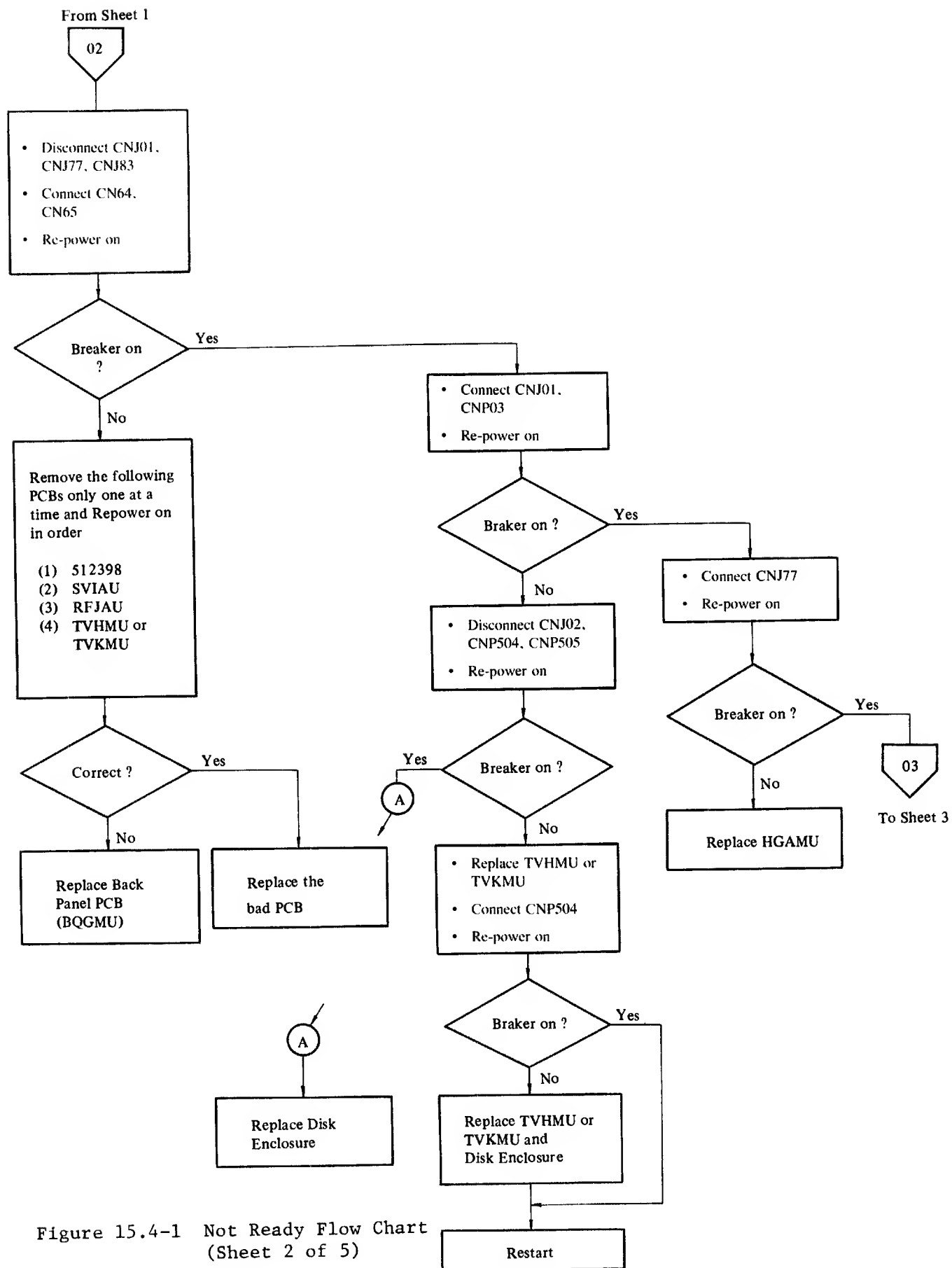


Figure 15.4-1 Not Ready Flow Chart  
(Sheet 2 of 5)

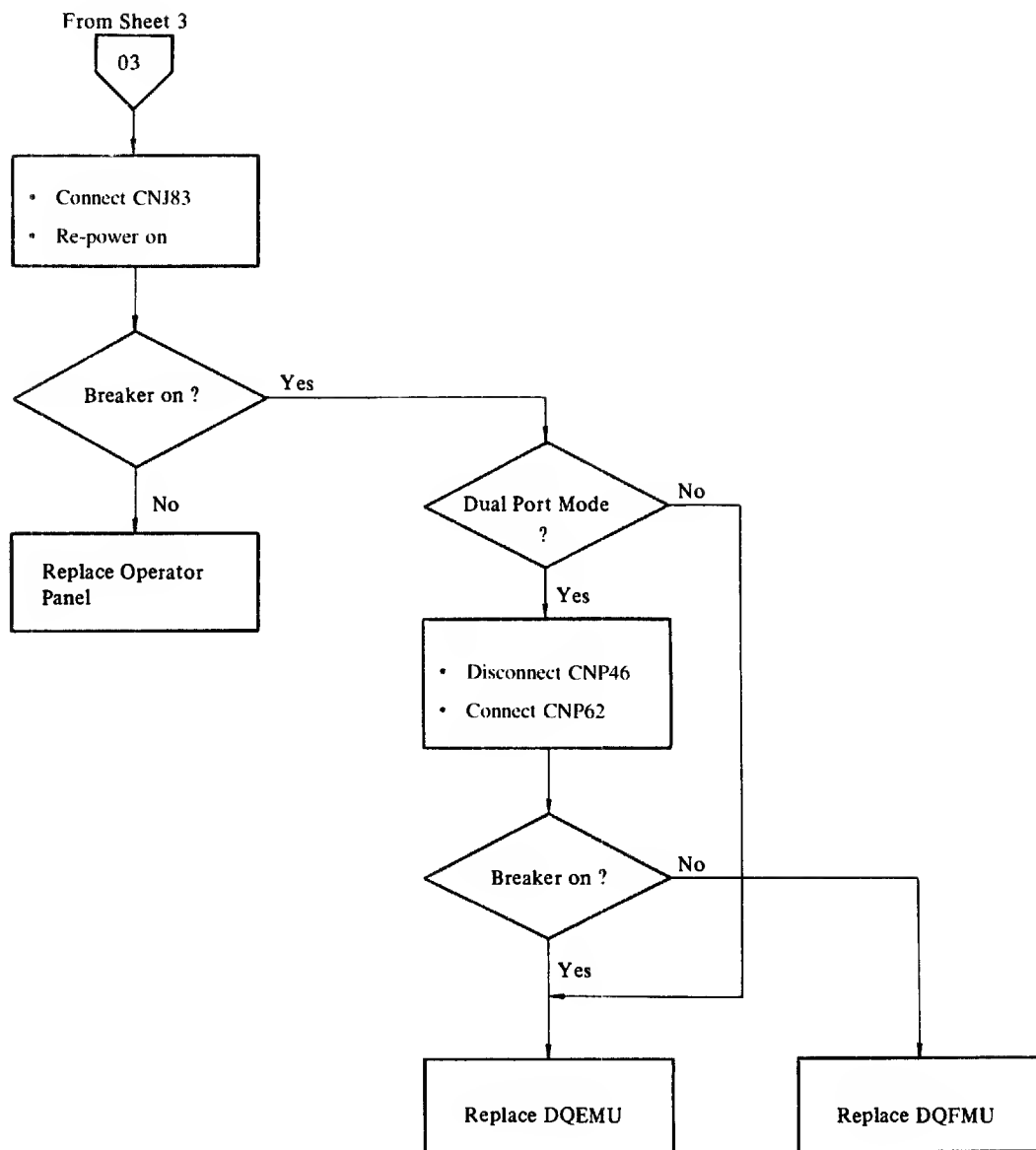


Figure 15.4-1 Not Ready Flow Chart  
(Sheet 3 of 5)

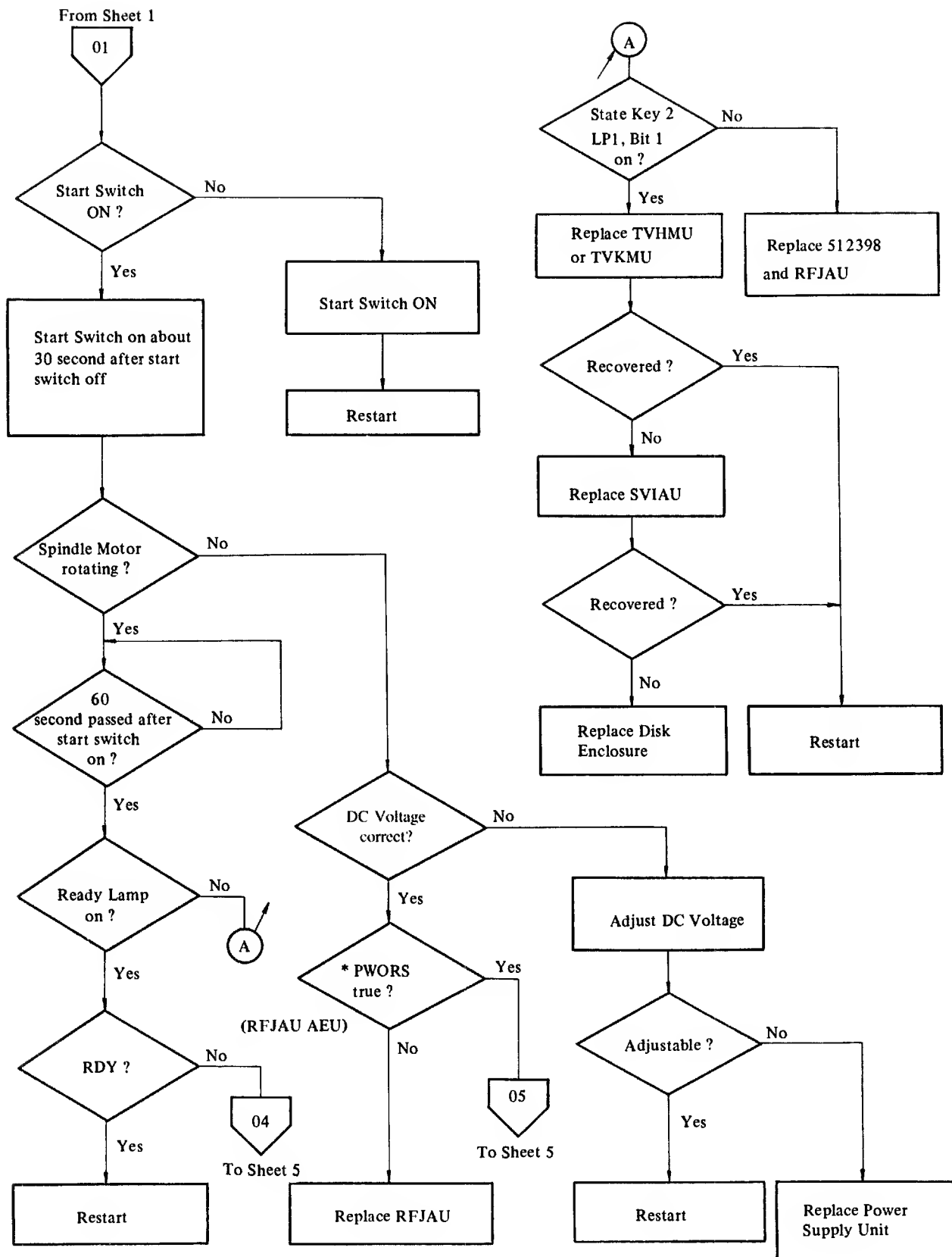


Figure 15.4-1 Not Ready Flow Chart  
(Sheet 4 of 5)

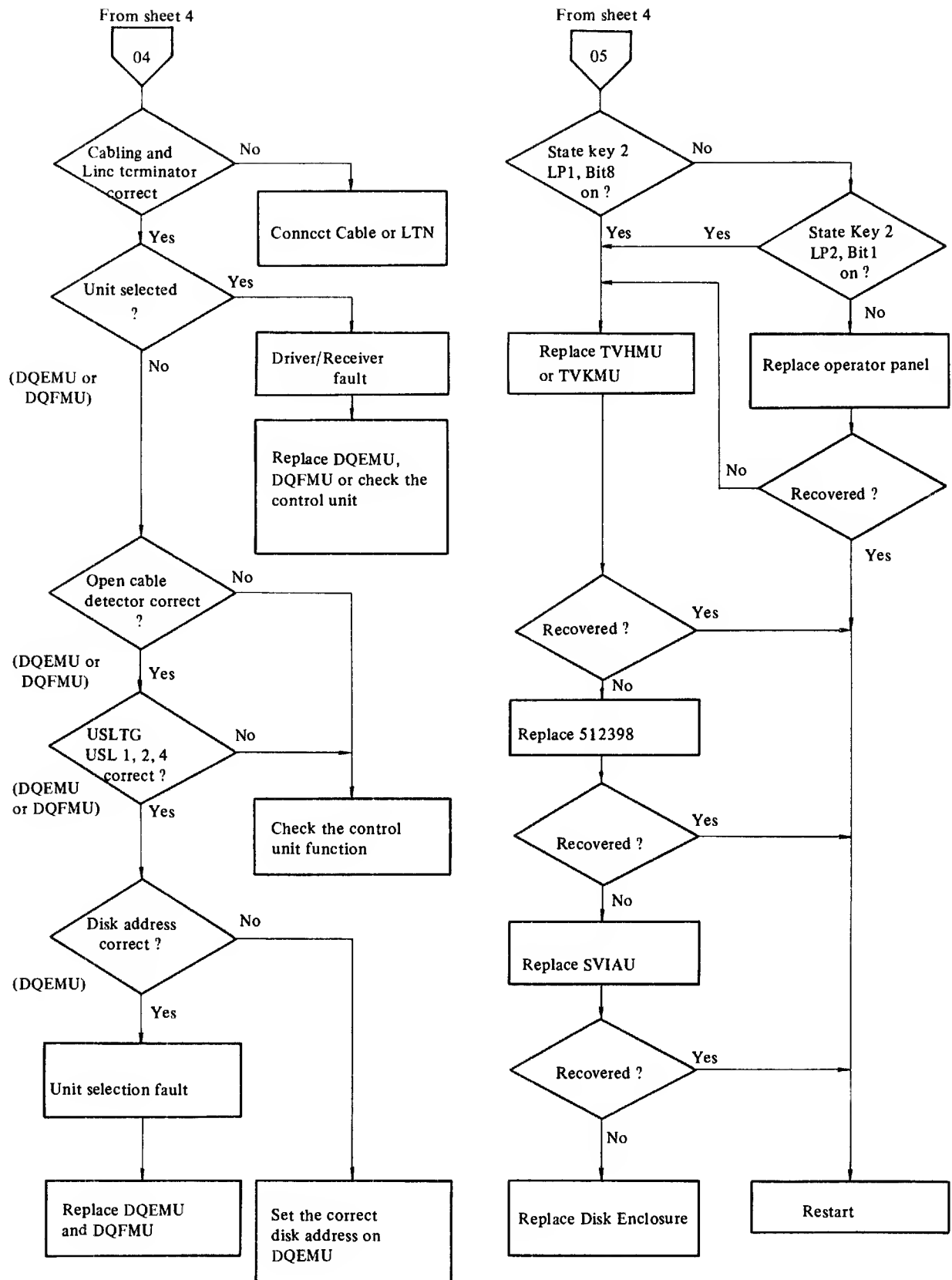


Figure 15.4-1 Not Ready Flow Chart  
(Sheet 5 of 5)

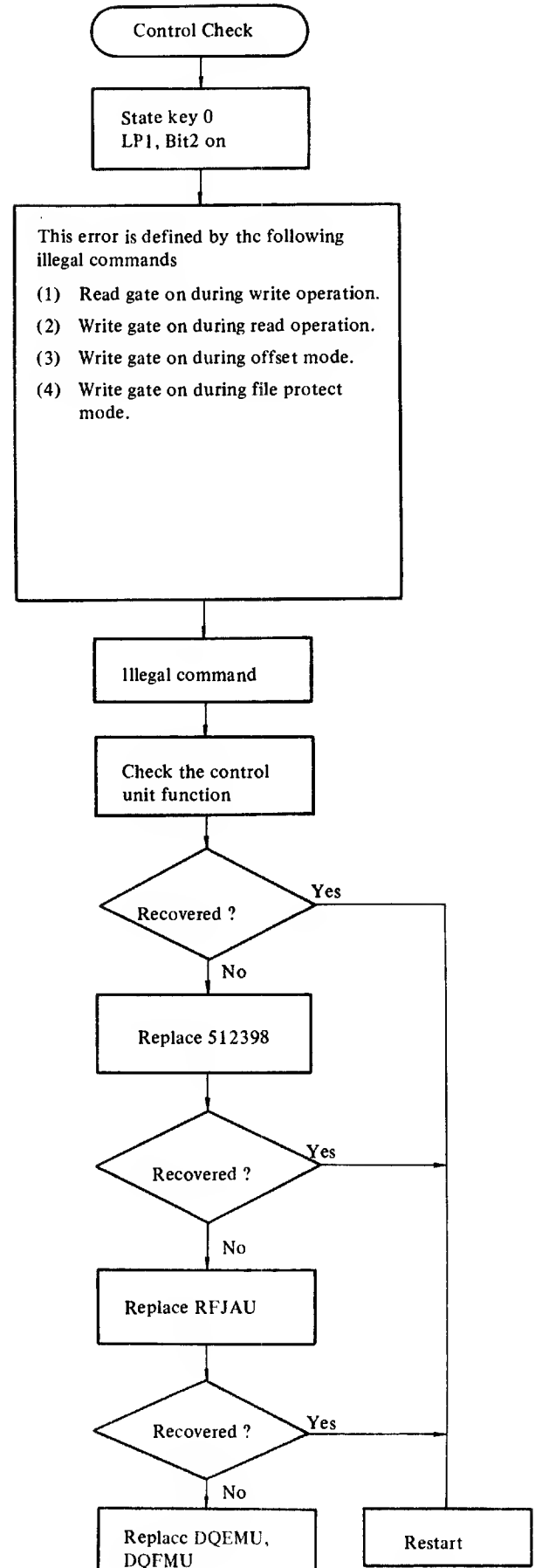
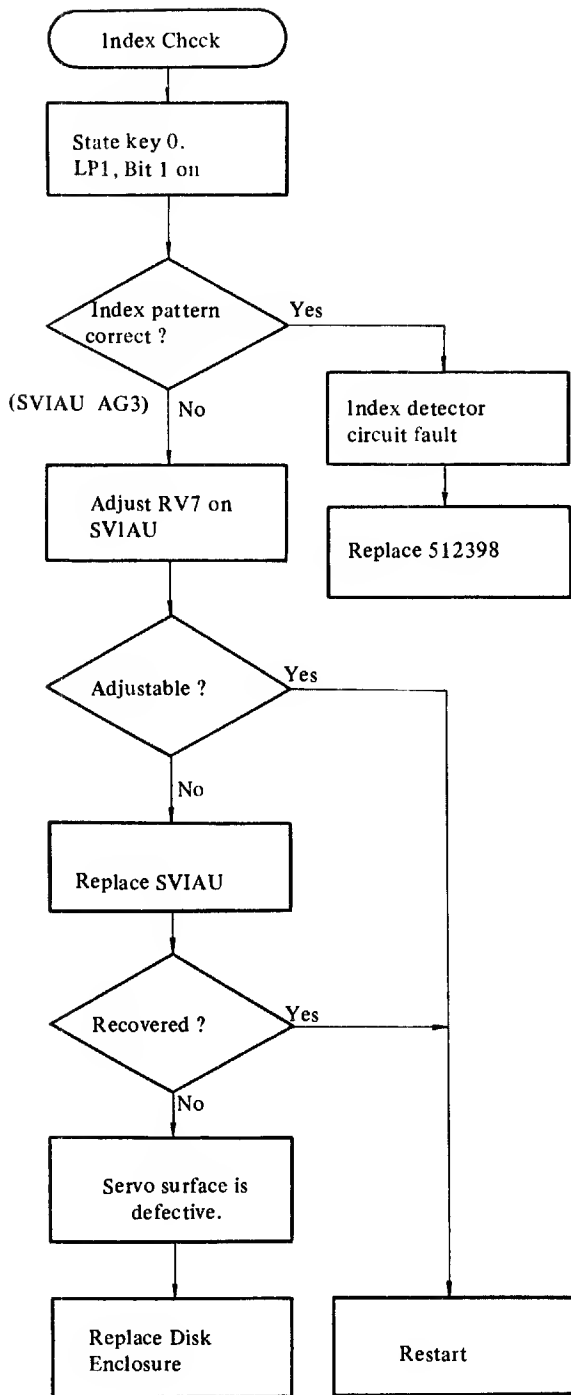


Figure 15.4-2 Fault Flow Chart  
(Sheet 1 of 4)



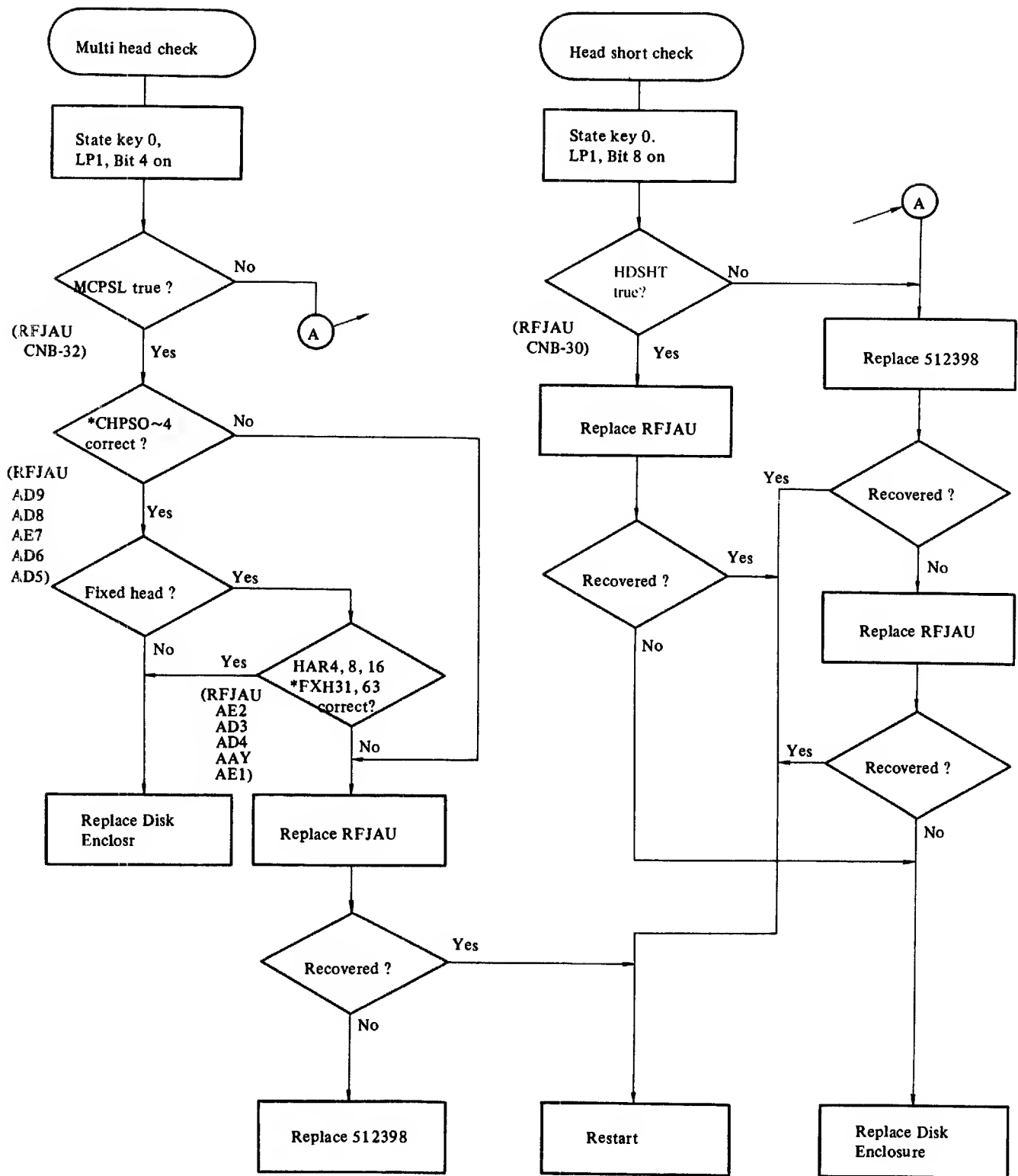


Figure 15.4-2 Fault Flow Chart (Sheet 2 of 4)

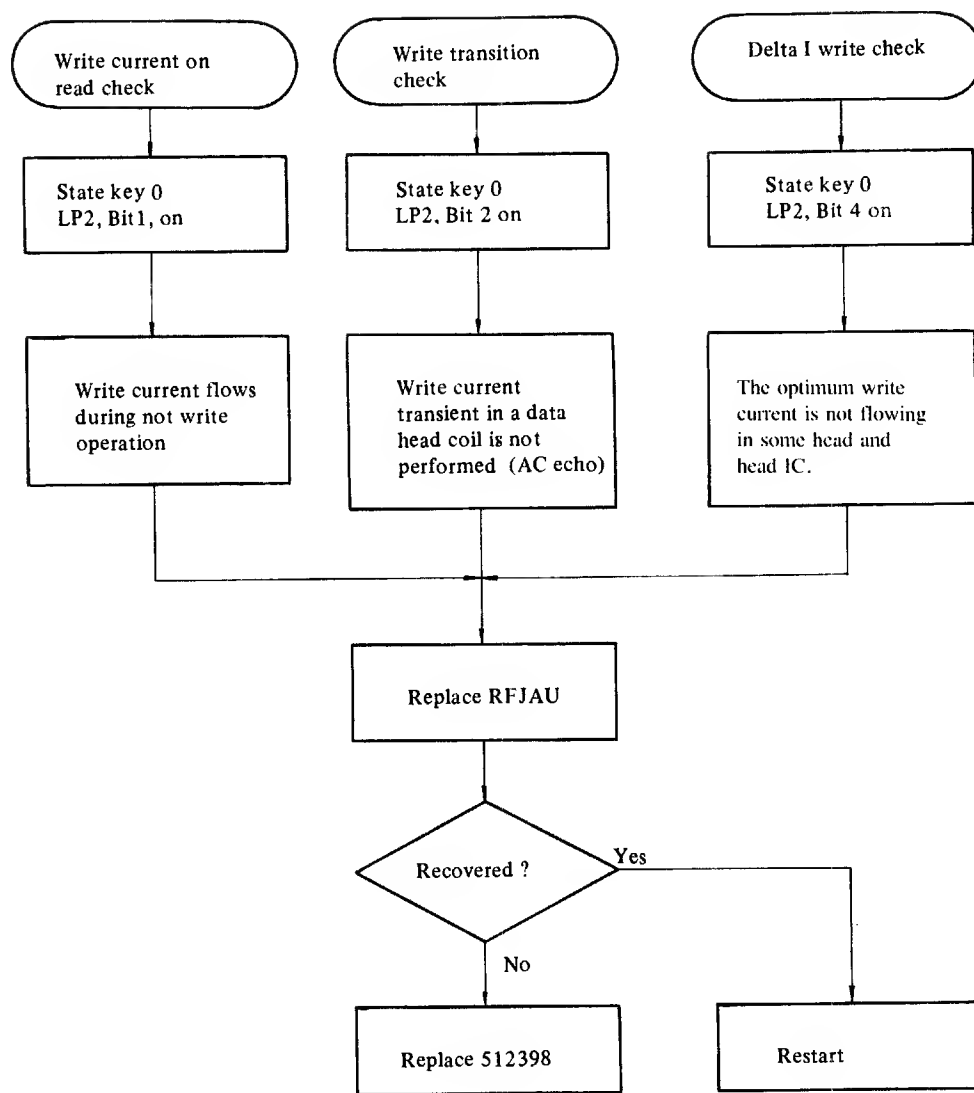


Figure 15.4-2 Fault Flow Chart (Sheet 3 of 4)

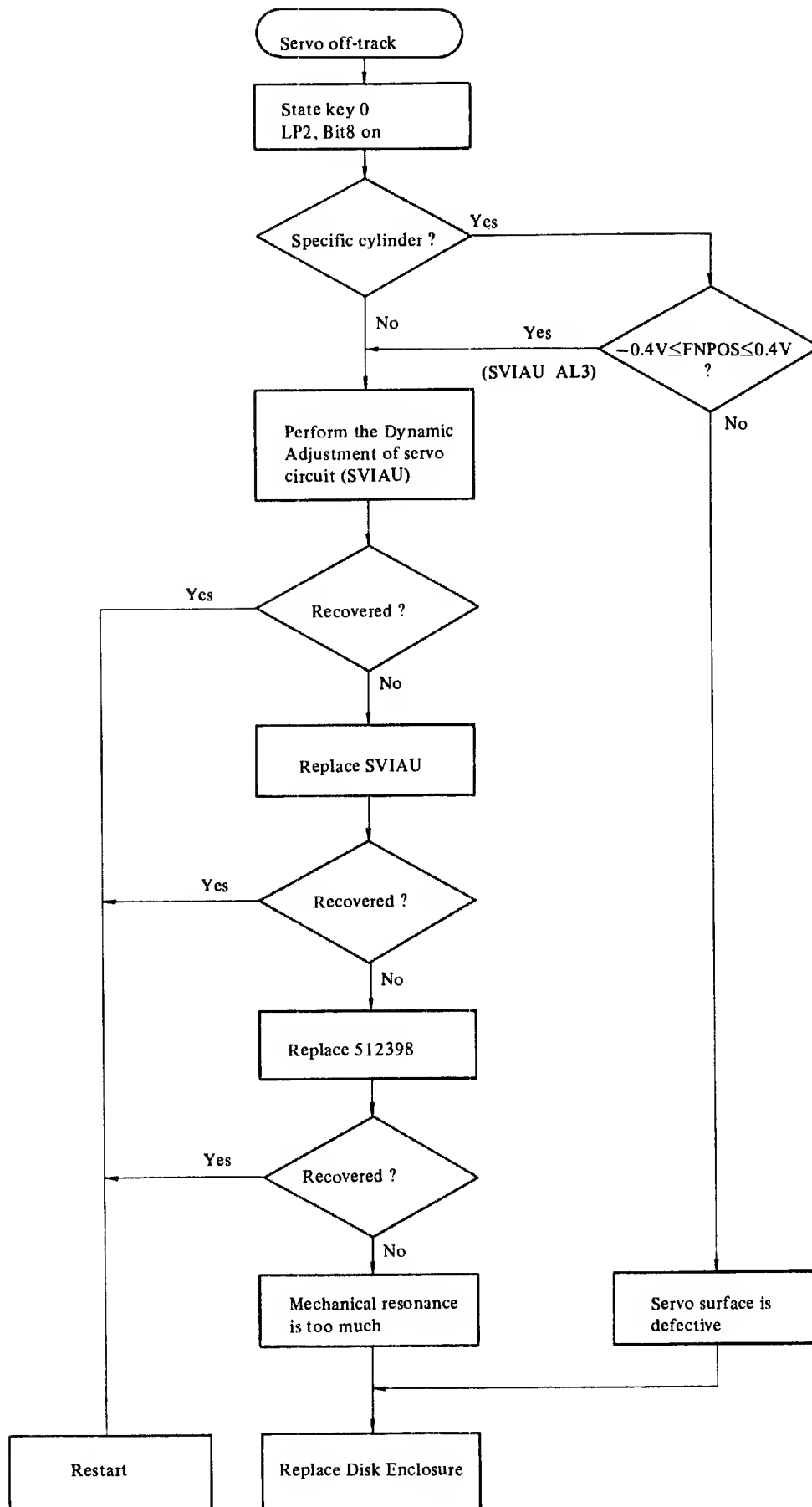


Figure 15.4-2 Fault Flow Chart (Sheet 4 of 4)

B03P-4655-0001A...E

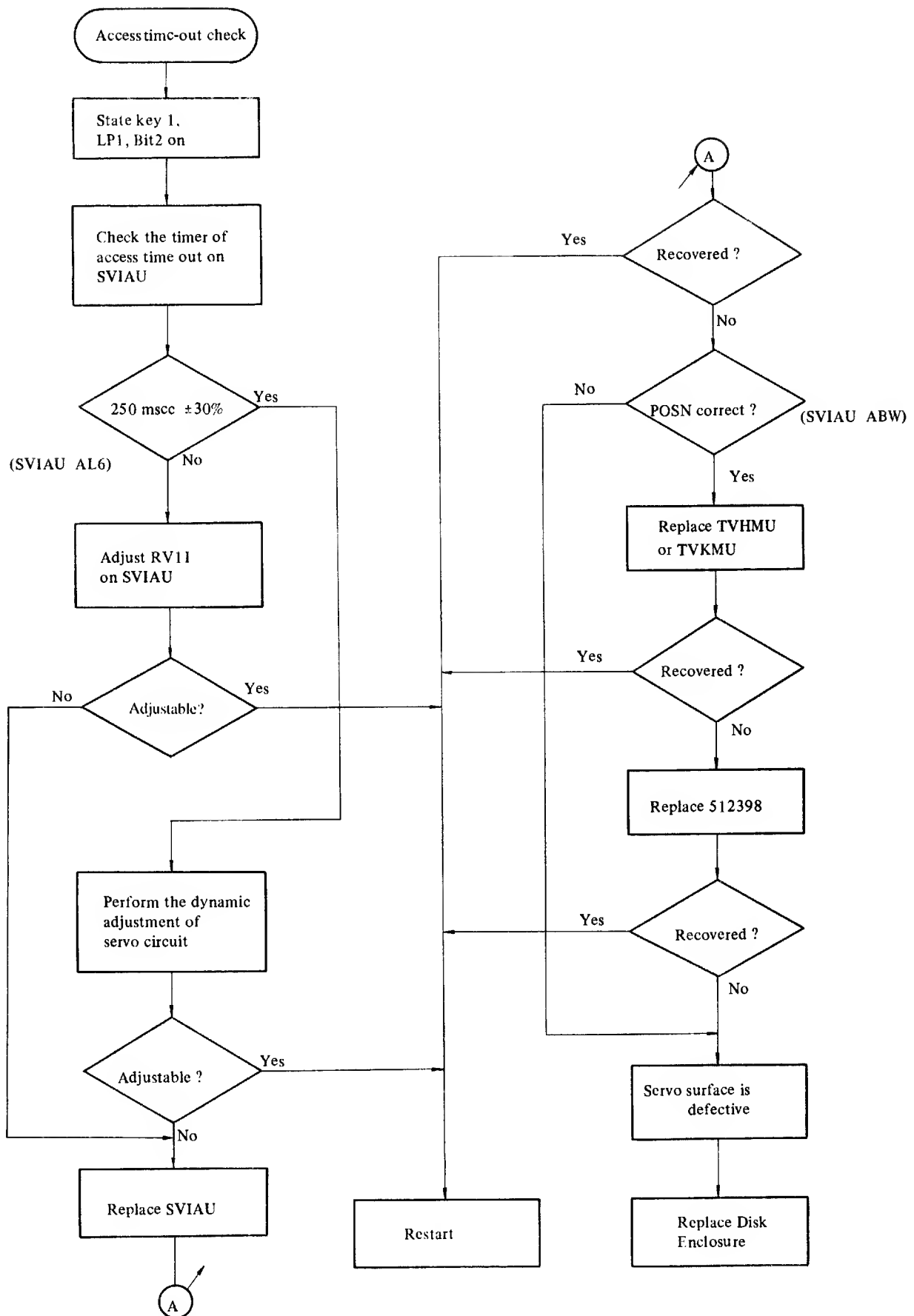
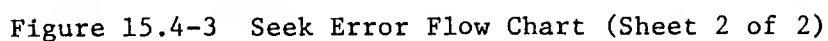
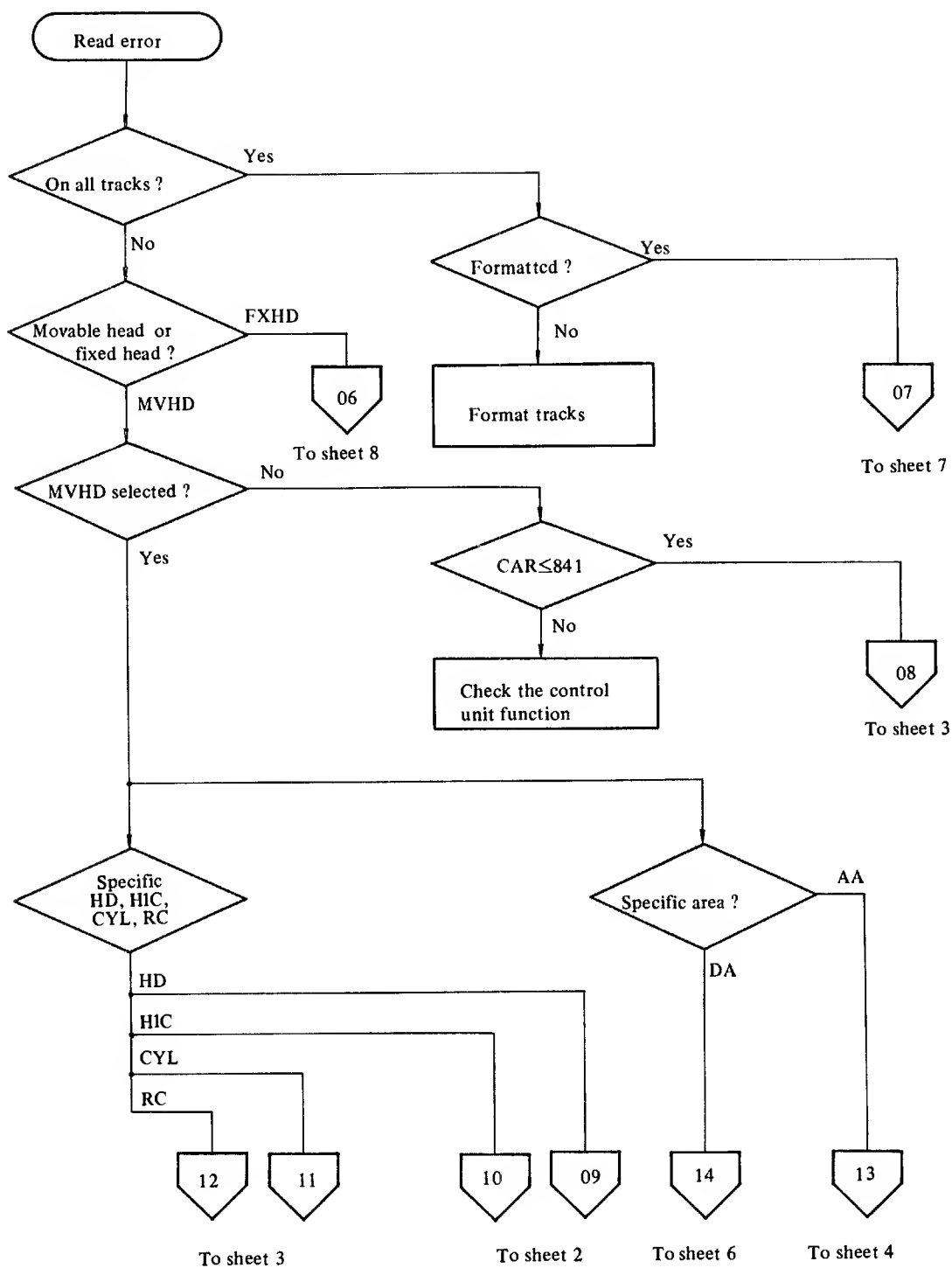


Figure 15.4-3 Seek Error Flow Chart (Sheet 1 of 2)





Note :  
 AA is address area  
 DA is data area  
 HD is head  
 HIC is head IC (or chip)  
 CYL is cylinder  
 RC is record

Figure 15.4-4 Read Error Flow Chart (Sheet 1 of 8)

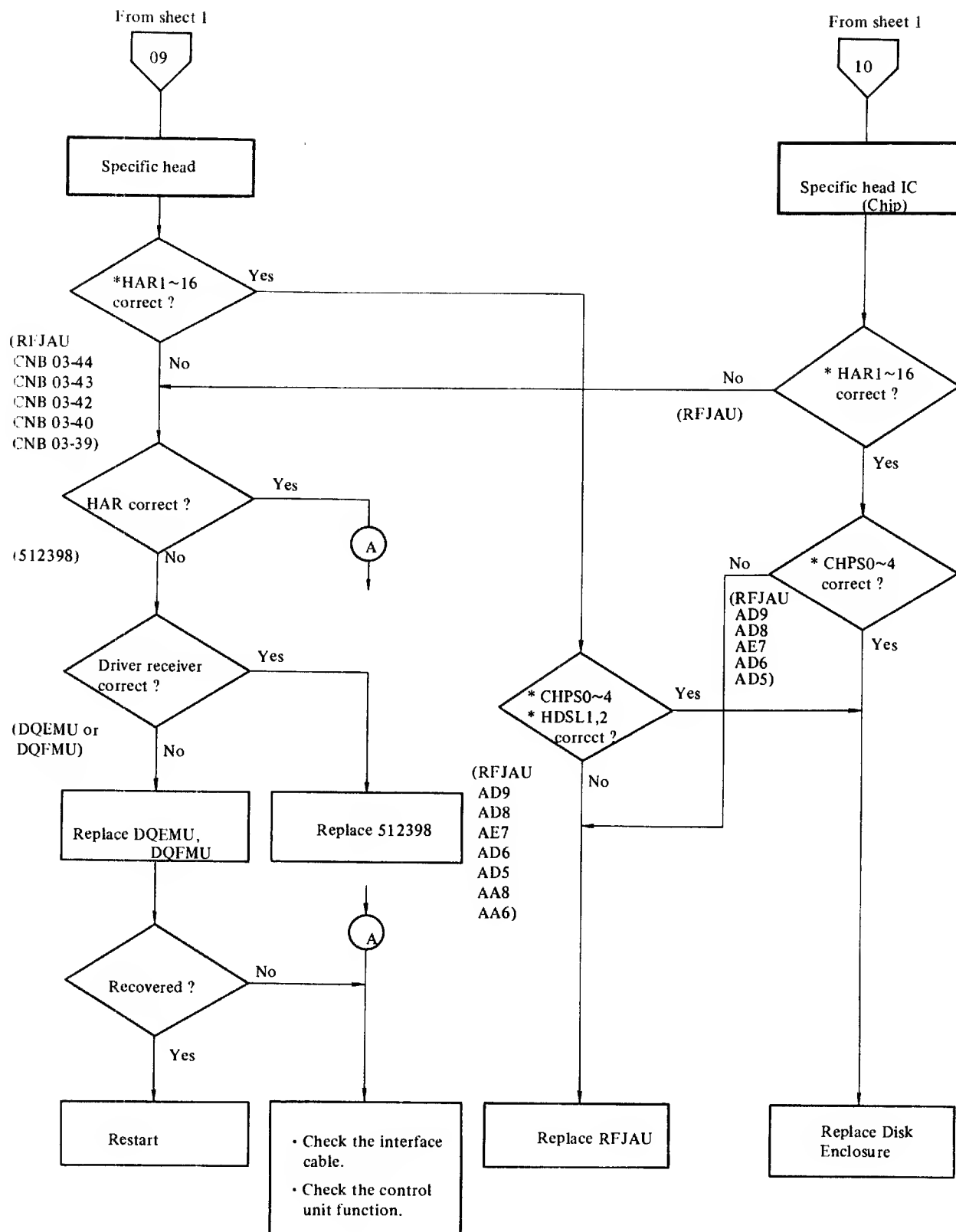


Figure 15.4-4 Read Error Flow Chart (Sheet 2 of 8)

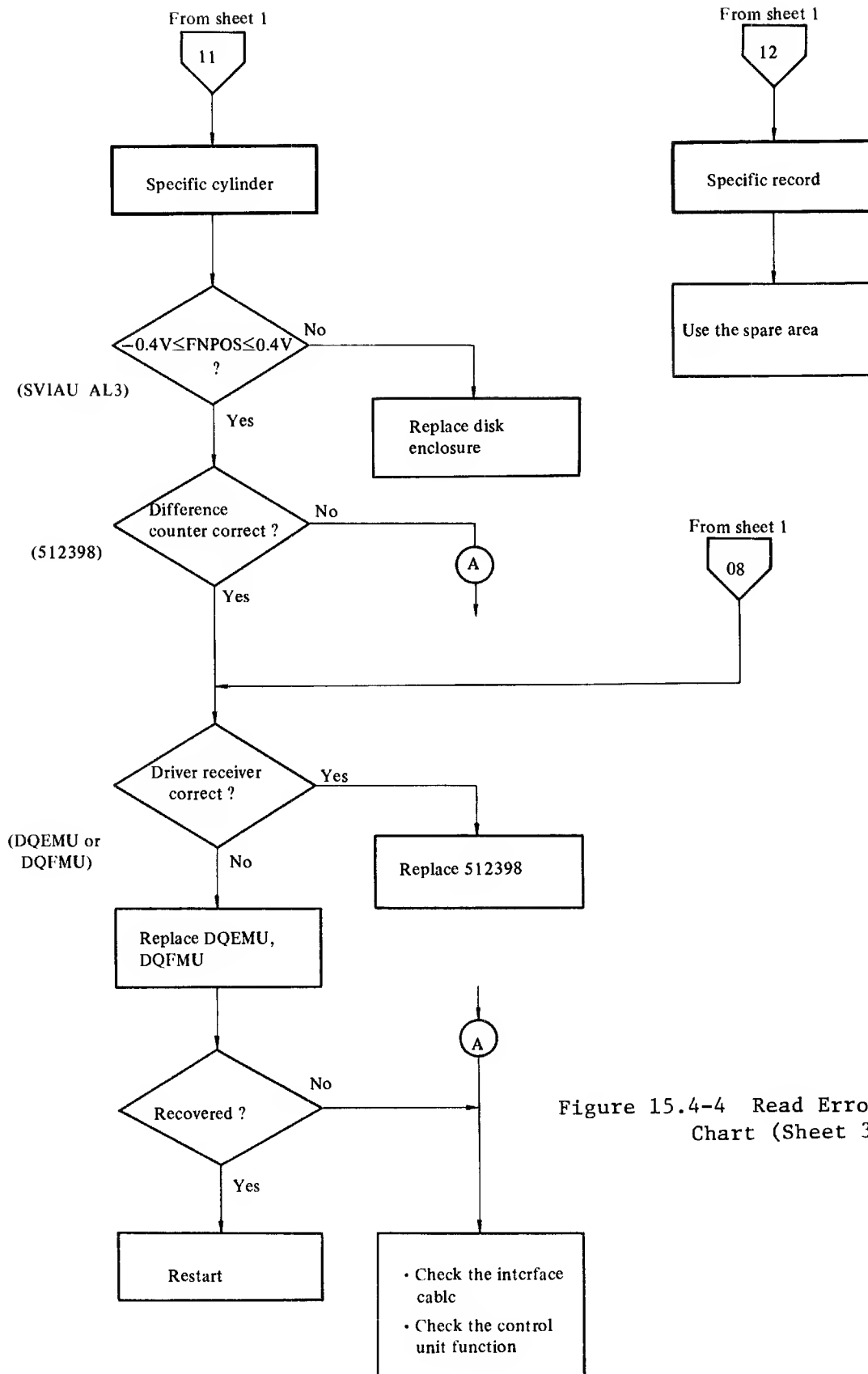


Figure 15.4-4 Read Error Flow Chart (Sheet 3 of 8)



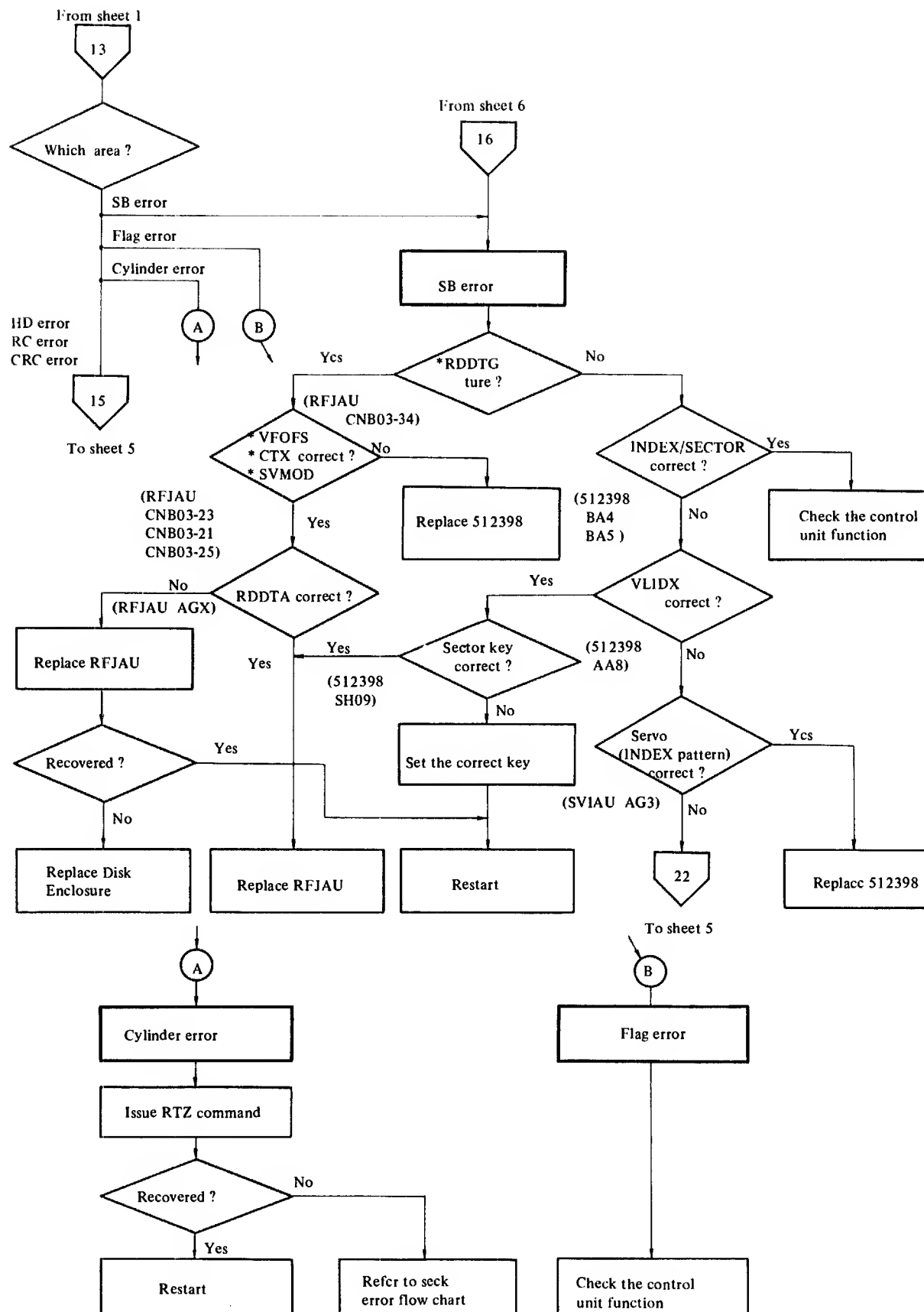


Figure 15.4-4 Read Error Flow Chart (Sheet 4 of 8)

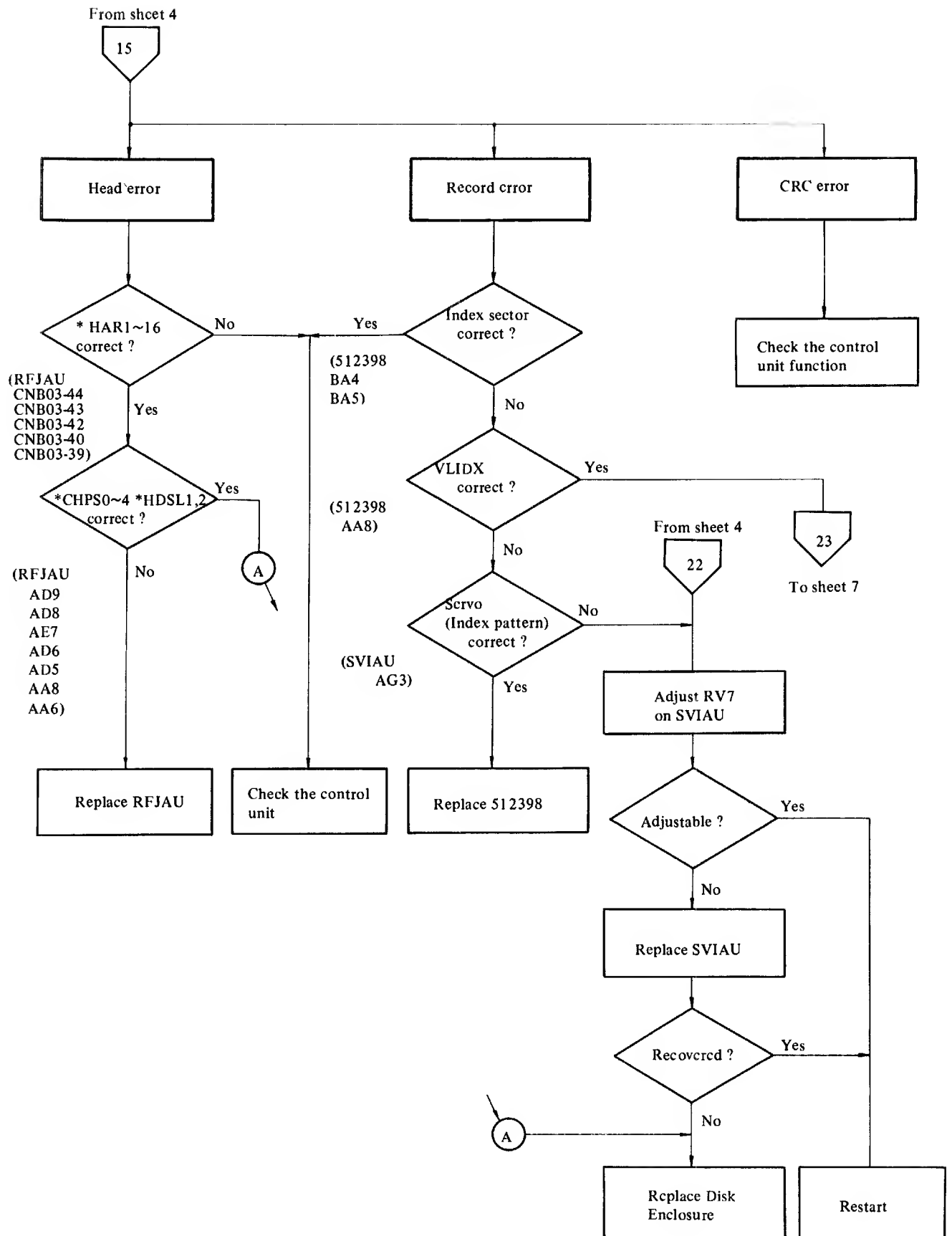


Figure 15.4-4 Read Error Flow Chart (Sheet 5 of 8)

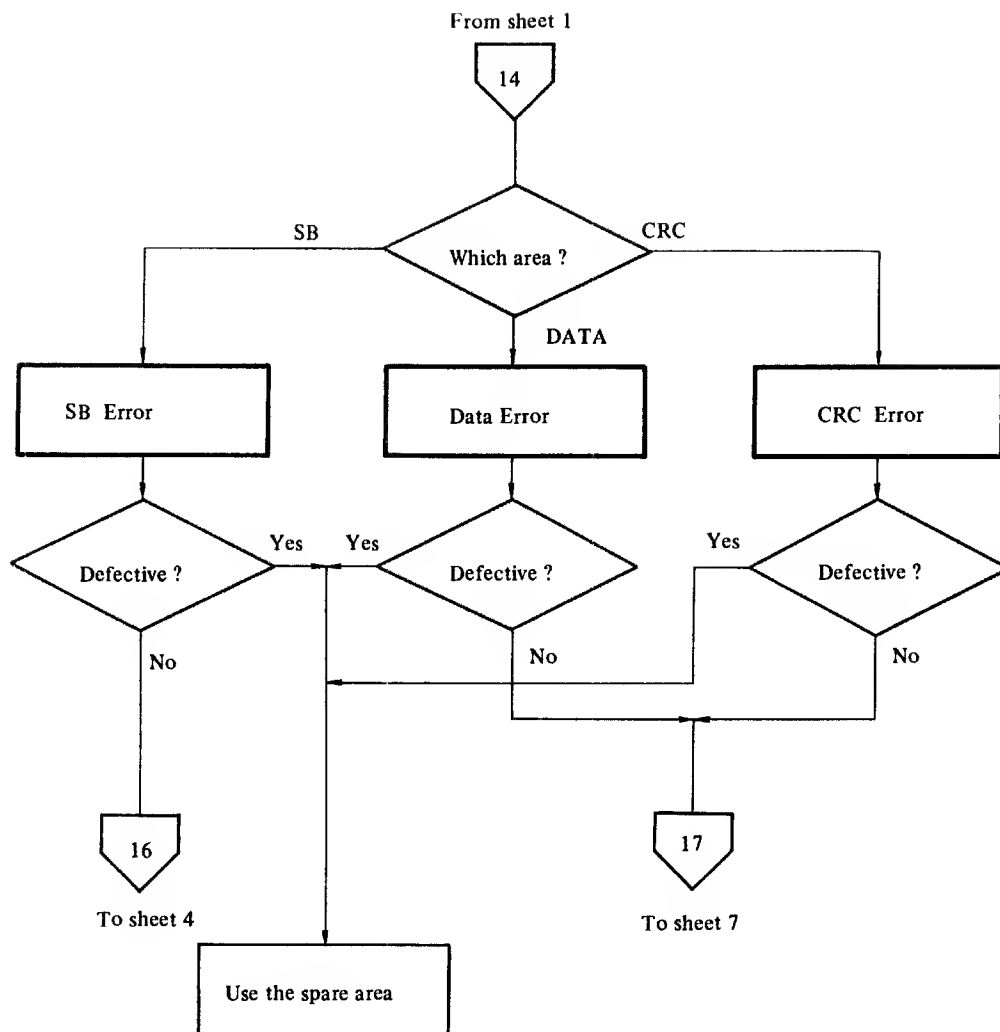


Figure 15.4-4 Read Error Flow Chart (Sheet 6 of 8)

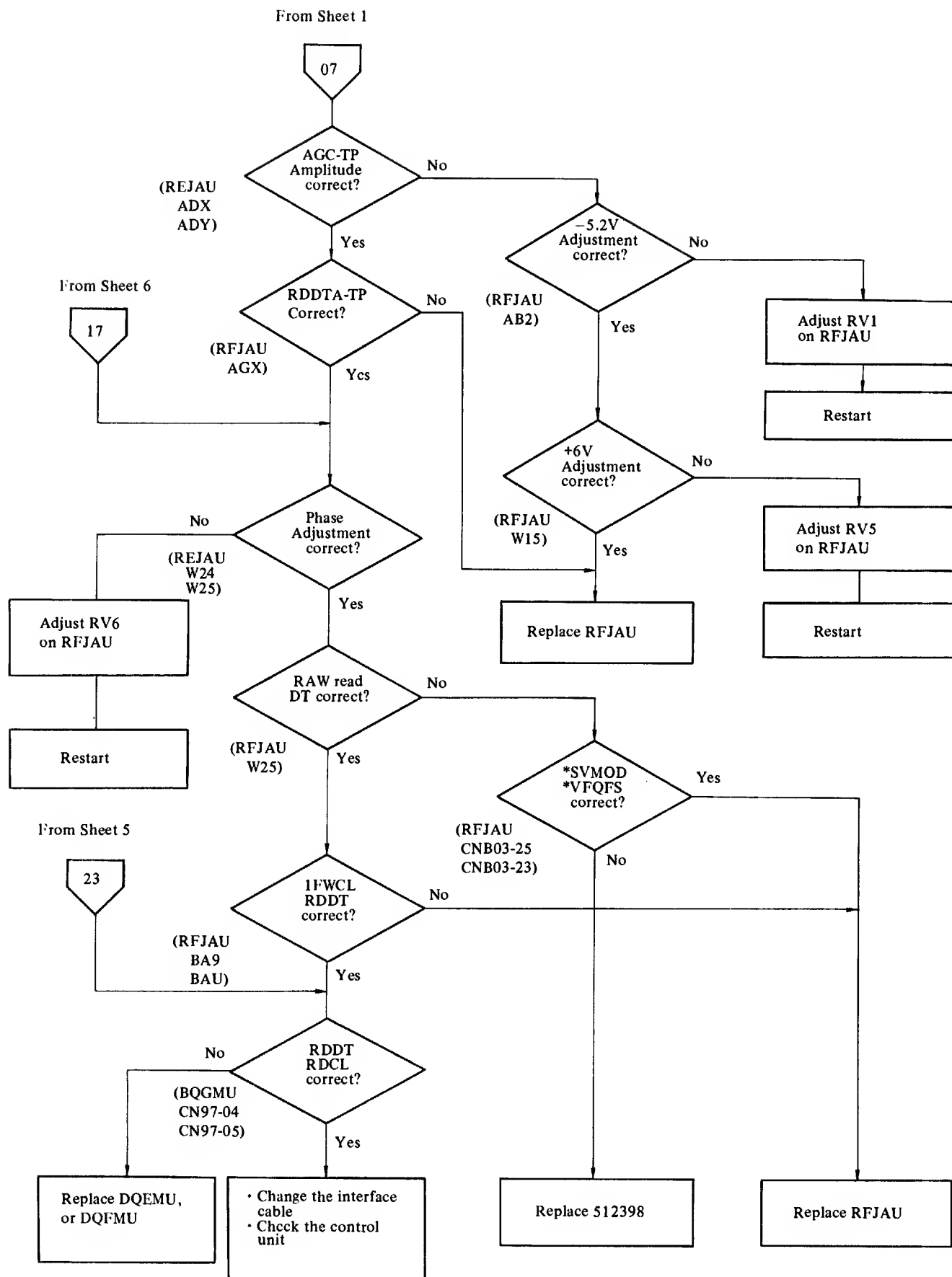
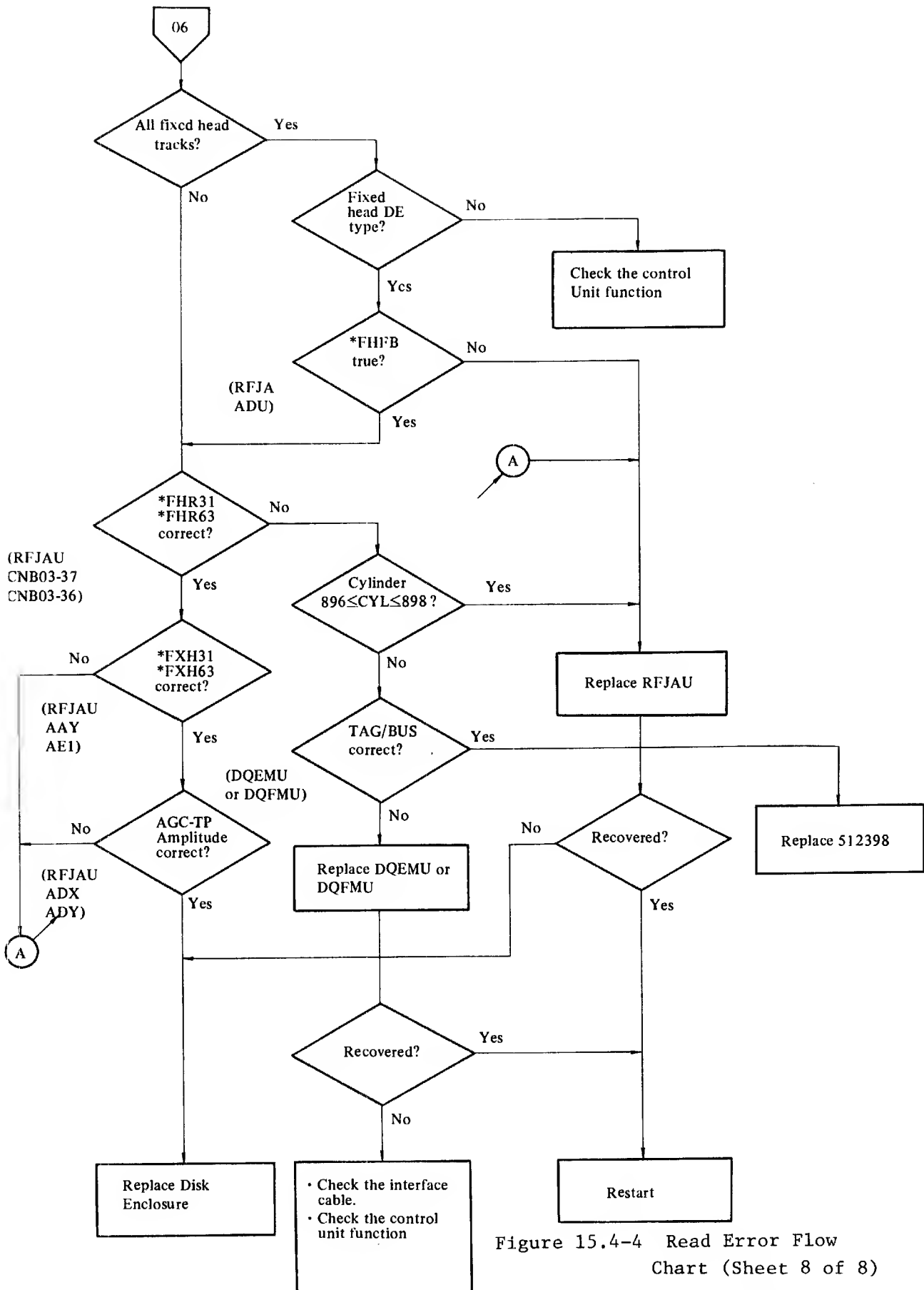


Figure 15.4-4 Read Error Flow Chart (Sheet 7 of 8)

Figure 15.4-4 Read Error Flow  
Chart (Sheet 8 of 8)

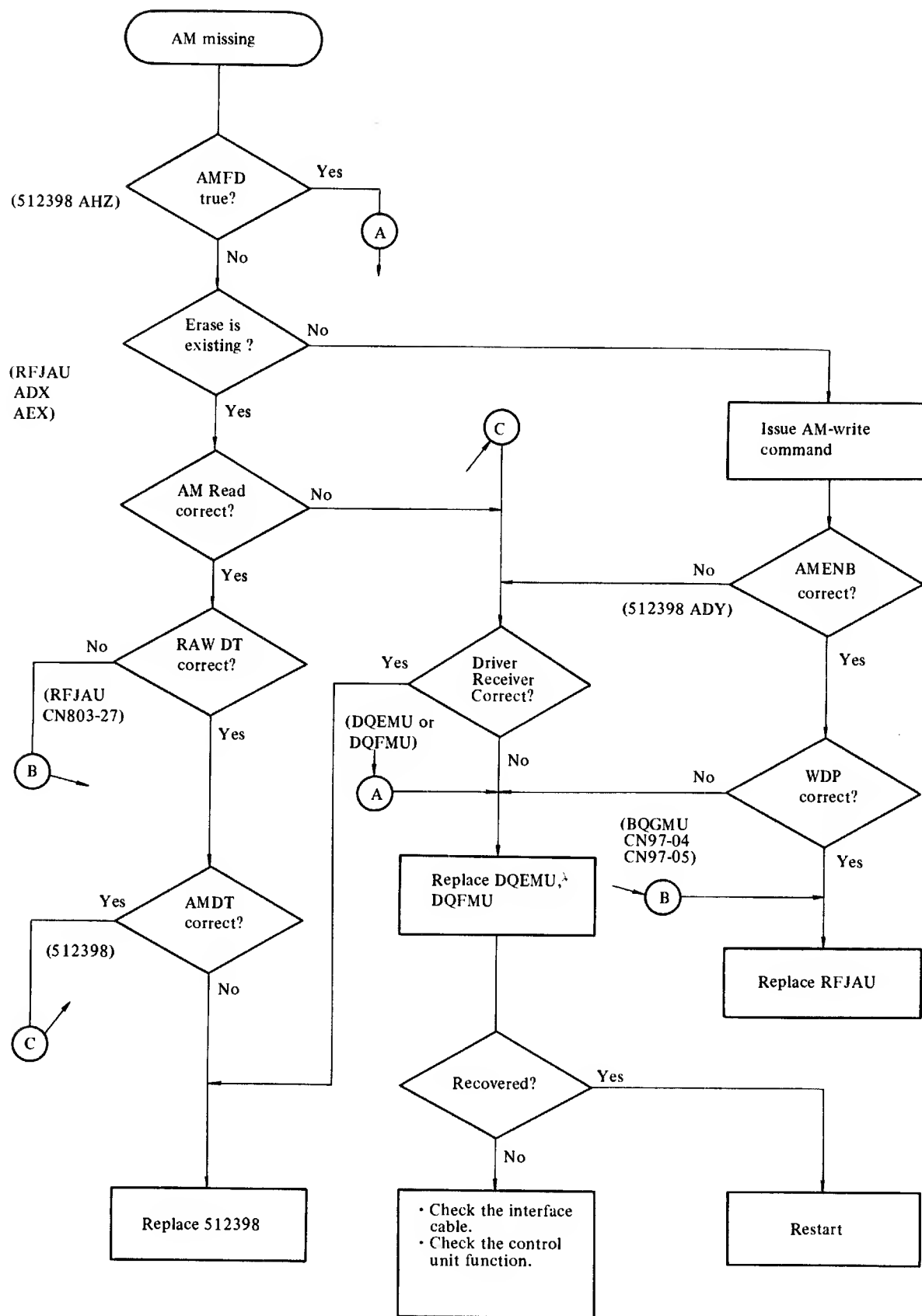


Figure 15.4-5 AM Missing Flow Chart (Sheet 1 of 1)



## 16.1 INTRODUCTION

This section describes the functions and interchangeability of TTL, ECL and Linear ICs used in the drive.

The specifications of input and output voltage level for each kind of IC are listed in Table 16.1-1.

Table 16.1-1 Input/Output Level

|                         | Input (V)         |                   | Output (V)       |                  |
|-------------------------|-------------------|-------------------|------------------|------------------|
|                         | High              | Low               | High             | Low              |
| TTL Medium Speed        | 5.5 ~ 2.0         | 0.8 ~ -0.5        | 5.25 ~ 2.4       | 0.4 ~ 0          |
| TTL Schottkey           | 5.5 ~ 2.0         | 0.8 ~ -0.3        | 5.25 ~ 2.7       | 0.5 ~ 0          |
| TTL Low Power Schottkey | 5.5 ~ 2.0         | 0.8 ~ -0.3        | 5.25 ~ 2.7       | 0.4 ~ 0          |
| ECL                     | -0.81 ~<br>-1.105 | -1.475 ~<br>-1.85 | -0.81 ~<br>-0.98 | -1.63 ~<br>-1.85 |

Logical "1" and "0" correspond to high and low level respectively for input or output of each kind of IC.



## 16.2 INTERCHANGEABILITY

(1) TTL (SSI/MSI)

| FUJITSU     |         | Direct Replacement | Function                               | Ref. No. |
|-------------|---------|--------------------|----------------------------------------|----------|
| Type No.    | Marking |                    |                                        |          |
| MB74LS00M   | LS00    | SN74LS00N          | Quad 2-Input NAND                      | 1        |
| MB74LS01M   | LS01    | SN74LS01N          | Quad 2-Input NAND . Open Collector     | 2        |
| MB74LS02M   | LS02    | SN74LS02N          | Quad 2-Input NOR                       | 3        |
| MB74LS04M   | LS04    | SN74LS04N          | Hex Inverter                           | 5        |
| MB74LS05M   | LS05    | SN74LS05N          | Hex Inverter . Open Collector          | 6        |
| MB74LS08M   | LS08    | SN74LS08N          | Quad 2-Input AND                       | 8        |
| MB74LS10M   | LS10    | SN74LS10N          | Triple 3-Input NAND                    | 9        |
| MB74LS11M   | LS11    | SN74LS11N          | Triple 3-Input AND                     | 10       |
| MB74LS20M   | LS20    | SN74LS20N          | Dual 4-Input NAND                      | 11       |
| MB74LS21M   | LS21    | SN74LS21N          | Dual 4-Input AND                       | 12       |
| MB74LS27M   | LS27    | SN74LS27N          | Triple 3-Input NOR                     | 13       |
| MB74LS32M   | LS32    | SN74LS32N          | Quad 2-Input OR                        | 14       |
| MB74LS37M   | LS37    | SN74LS37N          | Quad 2-Input NAND Buffer               | 1        |
| MB74LS42M   | LS42    | SN74LS42N          | BCD to Decimal Decoder                 | 16       |
| MB74LS74AM  | LS74    | SN74LS74N          | Dual D-Type Flip-Flop                  | 17       |
| MB74LS85M   | LS85    | SN74LS85N          | 4-bit Magnitude Comparator             | 18       |
| MB74LS86M   | LS86    | SN74LS86N          | Quad 2-Input EOR                       | 19       |
| MB74LS107M  | LS107   | SN74LS107N         | Dual J-K Flip-Flop                     | 20       |
| MB74LS153M  | LS153   | SN74LS153N         | Dual 4 to 1 Data Selector/Multiplexer  | 21       |
| MB74LS155M  | LS155   | SN74LS155N         | Dual 2 to 4 Decoder                    | 22       |
| MB74LS161AM | LS161   | SN74LS161N         | 4-bit Binary Counter                   | 23       |
| MB74LS164M  | LS164   | SN74LS164N         | 8-bit Shift Register                   | 24       |
| MB74LS175M  | LS175   | SN74LS175N         | Quad D-Type Flip-Flop                  | 15       |
| MB74LS191M  | LS191   | SN74LS191N         | 4-bit Up/Down Counter                  | 25       |
| (None)      | LS279   | SN74LS279N         | Quad R-S Latch                         | 26       |
| MB74LS283M  | LS283   | SN74LS283N         | 4-bit Full Adder                       | 27       |
| (None)      | LS123   | SN74LS123          | Dual Monostable                        | 28       |
| (None)      | LS221   | SN74LS221          | Dual Monostable                        | 29       |
| MB400M      | LA01    | SN7400N            | Quad 2-Input NAND                      | 1        |
| MB418M      | LA18    | SN7404N            | Hex Inverter                           | 5        |
| MB463M      | 463     | SN7438N            | Quad 2-Input NAND . Open Collector     | 30       |
| MB434M      | 434     | SN75451BP          | Dual 2-Input AND Buffer                | 31       |
| MB435M      | 435     | SN7437N            | Quad 2-Input NAND Buffer               | 32       |
| MB439M      | 439     | SN75450BN          | Dual 2-Input AND Buffer                | 33       |
| MB440M      | 440     | SN74123N           | Dual Monostable                        | 28       |
| MB443M      | LA23    | SN74145N           | BCD to Decimal Decoder                 | 34       |
| (None)      | LX32    | SN7406             | Hex Inverter                           | 7        |
| (None)      | LX26    | SN74157            | Quad D-Type Flip-Flop                  | 15       |
| (None)      | LX34    | SN74193            | 4-bit Binary Up/Down Counter           | 35       |
| (None)      | LX27    | SN74221            | Dual Monostable                        | 29       |
| (None)      | LX16    | SN75452            | Dual NAND Driver                       | 36       |
| MB74S00M    | S00     | SN74S00N           | Quad 2-Input NAND                      | 1        |
| MB74S03M    | S03     | SN74S03N           | Quad 2-Input NAND . Open Collector     | 4        |
| MB74S04M    | S04     | SN74S04N           | Hex Inverter                           | 5        |
| MB74S11M    | S11     | SN74S11N           | Triple 3-Input AND                     | 10       |
| (None)      | S112    | SN74S112N          | Dual J-K Flip-Flop                     | 37       |
| (None)      | S153    | SN74S153N          | Dual 4 to 1 Data Selector /Multiplexer | 21       |
| (None)      | 75107A  | SN75107AN          | Dual Receiver                          | 38       |
| (None)      | 75108A  | SN75108AN          | Dual Receiver                          | 38       |
| (None)      | 75110   | SN75110A           | Dual Dreiver                           | 39       |

Note: Direct replacements are ICs of TEXAS INSTRUMENTS INCORPORATED.

(2) TTL (Bipolar 500-Gate Master Slice LSI)

| FUJITSU  |         | Direct Replacement | Function       | Ref. No. |
|----------|---------|--------------------|----------------|----------|
| Type No. | Marking |                    |                |          |
| MB15139C | 15139   | (None)             | Access Control | 40       |
| MB15140C | 15140   | (None)             | HDA Sequencer  | 41       |

Note: All ICs are FUJITSU original.

(3) TTL (Bipolar 200-Gate Master Slice LSI)

| FUJITSU  |         | Direct Replacement | Function               | Ref. No. |
|----------|---------|--------------------|------------------------|----------|
| Type No. | Marking |                    |                        |          |
| MB14601M | 14601   | (None)             | Linear Motor Control   | 42       |
| MB14613M | 14613   | (None)             | Servo Pattern Detector | 43       |

Note: All ICs are FUJITSU original.

(4) ECL 10K

| FUJITSU  |         | Direct Replacement | Function                      | Ref. No. |
|----------|---------|--------------------|-------------------------------|----------|
| Type No. | Marking |                    |                               |          |
| MB10101C | 101     | MC10101L           | Quad 2-Input OR/NOR           | 44       |
| MB10102C | 102     | MC10102L           | Quad 2-Input NOR              | 45       |
| MB10105C | 105     | MC10105L           | Triple 2-3-2 OR/NOR           | 46       |
| MB10106C | 106     | MC10106L           | Triple 4-3-3 NOR              | 47       |
| MB10109C | 109     | MC10109L           | Dual 4-5 Input OR/NOR         | 48       |
| MB10116C | 116     | MC10116L           | Triple Line Receiver          | 49       |
| MB10124C | 124     | MC10124L           | Quad TTL to ECL Translator    | 50       |
| MB10125C | 125     | MC10125L           | Quad ECL to TTL Translator    | 51       |
| MB10131C | 131     | MC10131L           | Dual D-Type Flip-Flop         | 52       |
| MB10135C | 135     | MC10135L           | Dual J-K Flip-Flop            | 53       |
| (None)   | (None)  | HD103107           | Voltage Controlled Oscillator | 54       |

Note: MC is MOTOROLA Semiconductor Products Inc..

HD is Hitachi, Ltd..

## (5) Analog Master-Slice LSI

| FUJITSU  |         | Direct Replacement | Function                        | Ref. No. |
|----------|---------|--------------------|---------------------------------|----------|
| Type No. | Marking |                    |                                 |          |
| MB4306C  | A4306   | (None)             | Voltage Controlled Oscillator A | 55       |
| MB4311C  | A4311   | (None)             | Level Sensor                    | 56       |
| MB4313C  | A4303   | (None)             | AGC Amp.                        | 57       |
| MB4316C  | A4316   | (None)             | Read/Write Bus Switch C         | 58       |
| MB4319C  | A4319   | (None)             | Peak Hold                       | 59       |
| MB4112   | A4112   | SSI105             | Disk Head IC (Fixed Head)       | 60       |
| MB4113   | A4113   | (None)             | Disk Head IC (Movable Head)     | 60       |

Note: SSI is Silicon Systems Inc..

## (6) Analog IC

| FUJITSU  |         | Direct Replacement | Function                           | Ref. No. |
|----------|---------|--------------------|------------------------------------|----------|
| Type No. | Marking |                    |                                    |          |
| MB4002M  | A4002   |                    | High Speed Differential Comparator | 61       |
| MB3607M  | A1458   | MC1458             | Dual Operational Amplifier         | 62       |
| MB3501M  | A733    | $\mu$ A733DM       | Differential Video Amplifier       | 63       |
| MB5365AM | Q5365M  |                    | NPN Dual Transistors               | 64       |
| (None)   | A142    | $\mu$ PC142A       | Negative Voltage Regulator         | 65       |
| (None)   | A741    | $\mu$ PC151C       | Frequency Compensated Op . Amp.    | 66       |
| (None)   | A318    | $\mu$ PC159A       | High Speed Wide Band Op. Amp.      | 67       |
| (None)   | A311    | $\mu$ PC271C       | Voltage Comparator                 | 68       |
| (None)   | A610    | $\mu$ PC610D       | 10-Bit D/A Converter               | 69       |
| (None)   | Q049AX  | $\mu$ PA49A        | PNP Dual Transistors               | 70       |
| (None)   | A201    | DG201BK            | Quad Analog Switches               | 71       |
| (None)   | A555M   | M51841P            | Timing Circuit                     | 72       |
| (None)   | A1590   | MC1590G            | AGC Amplifier                      | 73       |

Note: MC is MOTOROLA Semiconductor Products Inc..

$\mu$ A is Fairchild Camera and Instrument Corporation.

$\mu$ PC and  $\mu$ PA are NIPPON Electric Co., Ltd..

DG is Siliconix Incorporated.

M is Mitsubishi Electric Co., Ltd..

## (7) Memory IC

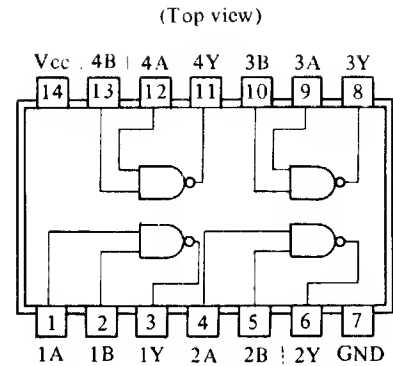
| FUJITSU  |         | Direct Replacement | Function                        | Ref. No. |
|----------|---------|--------------------|---------------------------------|----------|
| Type No. | Marking |                    |                                 |          |
| MB7055C  | 7055    | (None)             | 1024 $\times$ 8 (8192) Bit PROM | 74       |

### 16.3 DETAIL OF ICs

- (1) MB74LS00M (SN74LS00N)  
 MB400M (SN7400N)  
 MB74S00M (SN74S00N)  
 MB74LS37M (SN74LS37N)

QUADRUPLE 2-INPUT  
 POSITIVE-NAND GATES

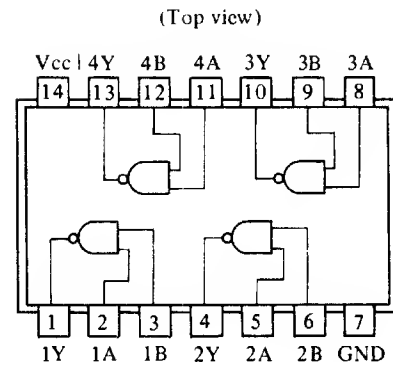
positive logic:  $Y = \overline{AB}$



- (2) MB74LS01M (SN74LS01N)

QUADRUPLE 2-INPUT  
 POSITIVE-NAND GATES  
 WITH OPEN-COLLECTOR OUTPUTS

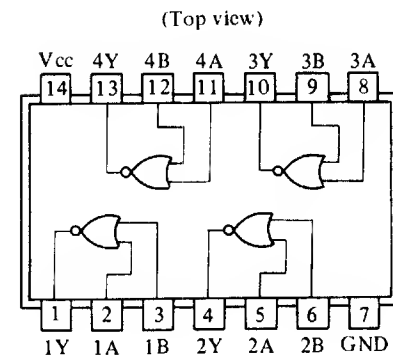
positive logic:  $Y = \overline{AB}$



- (3) MB74LS02M (SN74LS02N)

QUADRUPLE 2-INPUT  
 POSITIVE-NOR GATES

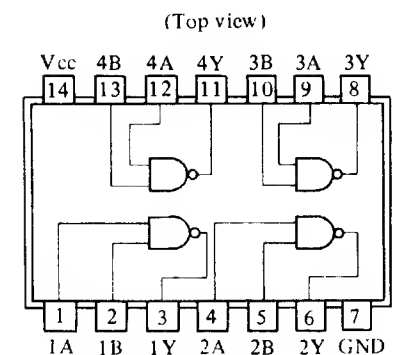
positive logic:  $Y = \overline{A+B}$



- (4) MB74S03M (SN74S03N)

QUADRUPLE 2-INPUT  
 POSITIVE-NAND GATES  
 WITH OPEN-COLLECTOR OUTPUTS

positive logic:  $Y = \overline{AB}$

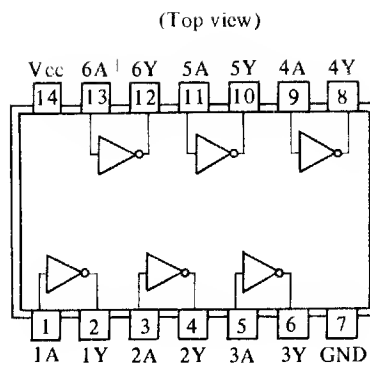


- (5) MB74LS04M (SN74LS04N)  
 MB418M (SN7404N)  
 MB74S04M (SN74S04N)

HEX INVERTERS

positive logic:

$$Y = \overline{A}$$



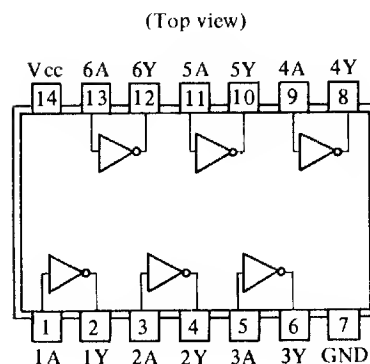
- (6) MB74LS05M (SN74LS05N)

HEX INVERTERS

WITH OPEN-COLLECTOR OUTPUTS

positive logic:

$$Y = \overline{A}$$

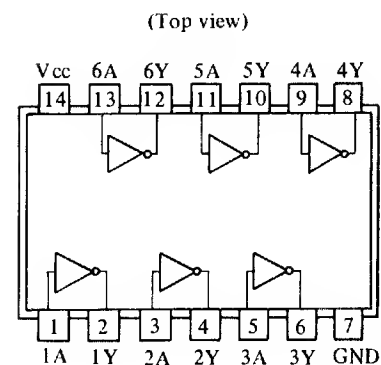


- (7) SN7406

HEX INVERTER BUFFERS/DRIVERS  
 WITH OPEN-COLLECTOR  
 HIGH-VOLTAGE OUTPUTS

positive logic:

$$Y = \overline{A}$$

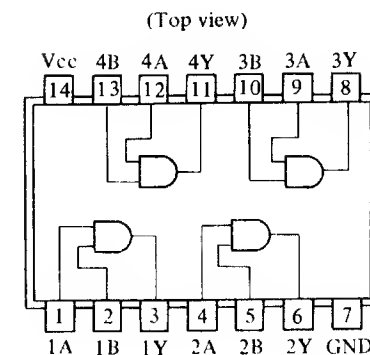


- (8) MB74LS08M (SN74LS08N)

QUADRUPLE 2-INPUT  
 POSITIVE-AND GATES

positive logic:

$$Y = AB$$

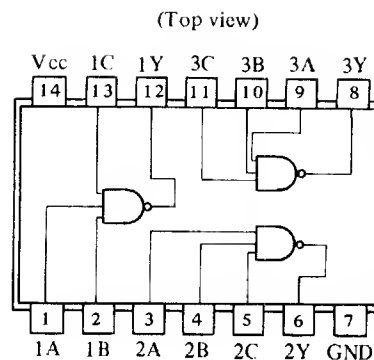


(9) MB74LS10M (SN74LS10N)

TRIPLE 3-INPUT  
POSITIVE-NAND GATES

positive logic:

$$Y = \overline{ABC}$$

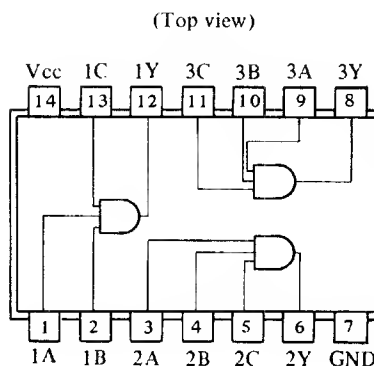


(10) MB74LS11M (SN74LS11N)  
SN74LS11N

TRIPLE 3-INPUT  
POSITIVE-AND GATES

positive logic:

$$Y = ABC$$

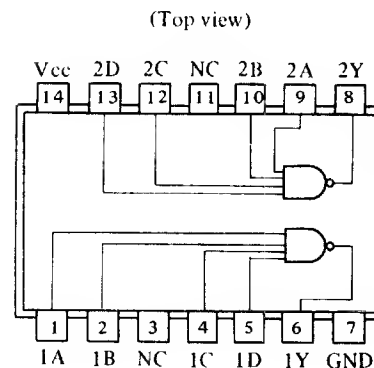


(11) MB74LS20M (SN74LS20N)

DUAL 4-INPUT  
POSITIVE-NAND GATES

positive logic:

$$Y = \overline{ABCD}$$

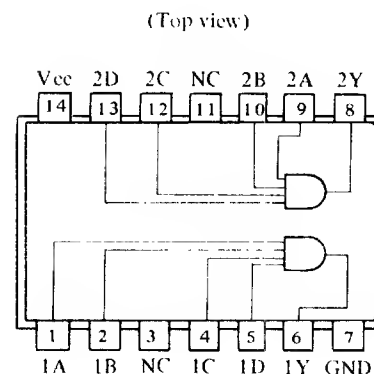


(12) MB74LS21M (SN74LS21N)

DUAL 4-INPUT  
POSITIVE-AND GATES

positive logic:

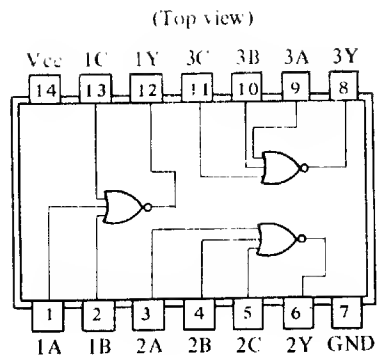
$$Y = ABCD$$



(13) MB74LS27M (SN74LS27N)

TRIPLE 3-INPUT  
POSITIVE-NOR GATES

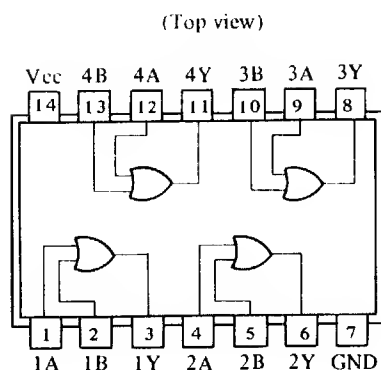
Positive logic:  
 $Y = \overline{A+B+C}$



(14) MB74LS32M (SN74LS32N)

QUADRUPLE 2-INPUT  
POSITIVE-OR GATES

positive logic:  
 $Y = A+B$



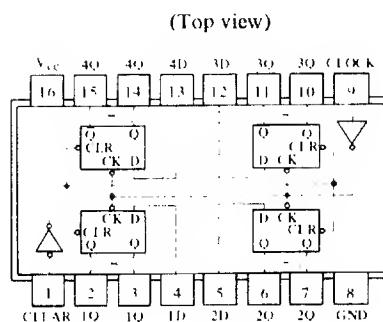
(15) SN74175

QUADRUPLE D-TYPE FLIP-FLOPS

Positive logic;

FUNCTION TABLE  
(EACH FLIP-FLOP)

| INPUT |       |   | OYTPUTS        |                  |
|-------|-------|---|----------------|------------------|
| CLEAR | CLOCK | D | Q              | Q <sup>↑</sup>   |
| L     | X     | X | L              | H                |
| H     | ↑     | H | H              | L                |
| H     | ↑     | L | L              | H                |
| H     | L     | X | Q <sub>0</sub> | $\overline{Q_0}$ |



H = High level (steady state)

L = low level (steady state)

X = irrelevant

↑ = transition from low to high level

Q<sub>0</sub> = the level of Q before the indicated steady-state input conditions were established.

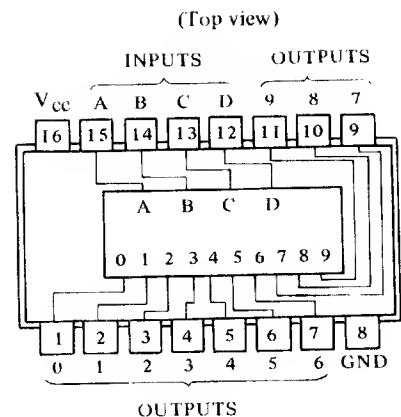
(16) MB74LS42M (SN74LS42N)  
BCD TO DECIMAL DECODER

Positive logic;

FUNCTION TABLE

| No.     | BCD INPUT |   |   |   | DECIMAL OUTPUT |   |   |   |   |   |   |   |   |   |
|---------|-----------|---|---|---|----------------|---|---|---|---|---|---|---|---|---|
|         | D         | C | B | A | 0              | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0       | L         | L | L | L | L              | H | H | H | H | H | H | H | H | H |
| 1       | L         | L | L | H | H              | L | H | H | H | H | H | H | H | H |
| 2       | L         | L | H | L | H              | H | L | H | H | H | H | H | H | H |
| 3       | L         | L | H | H | H              | H | L | H | H | H | H | H | H | H |
| 4       | L         | H | L | L | H              | H | H | L | H | H | H | H | H | H |
| 5       | L         | H | L | H | H              | H | H | H | L | H | H | H | H | H |
| 6       | L         | H | H | L | H              | H | H | H | H | L | H | H | H | H |
| 7       | L         | H | H | H | H              | H | H | H | H | H | L | H | H | H |
| 8       | H         | L | L | L | H              | H | H | H | H | H | H | L | H | H |
| 9       | H         | L | L | H | H              | H | H | H | H | H | H | H | L | H |
| INVALID | H         | L | H | L | H              | H | H | H | H | H | H | H | H | H |
|         | H         | L | H | H | H              | H | H | H | H | H | H | H | H | H |
|         | H         | H | L | L | H              | H | H | H | H | H | H | H | H | H |
|         | H         | H | L | H | H              | H | H | H | H | H | H | H | H | H |
|         | H         | H | H | L | H              | H | H | H | H | H | H | H | H | H |

H = high level      L = low level



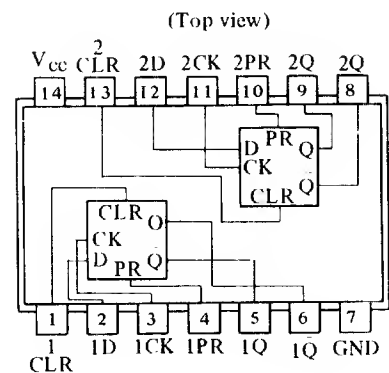
(17) MB74LS74AM (SN74LS74N)  
DUAL D-TYPE POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

Positive logic;

FUNCTION TABLE

| INPUTS |       |       |   | OUTPUTS        |             |
|--------|-------|-------|---|----------------|-------------|
| PRESET | CLEAR | CLOCK | D | Q              | $\bar{Q}$   |
| L      | H     | X     | X | H              | L           |
| H      | L     | X     | X | L              | H           |
| L      | L     | X     | X | H*             | H*          |
| H      | H     | ↑     | H | H              | L           |
| H      | H     | ↑     | L | L              | H           |
| H      | H     | L     | X | Q <sub>0</sub> | $\bar{Q}_0$ |

\* This configuration is nonstable;  
that is, it will not persist when  
preset and clear inputs return to  
their inactive (high) level.





(18) MB74LS85M (SN74LS85N)

4-BIT MAGNITUDE COMPARATOR

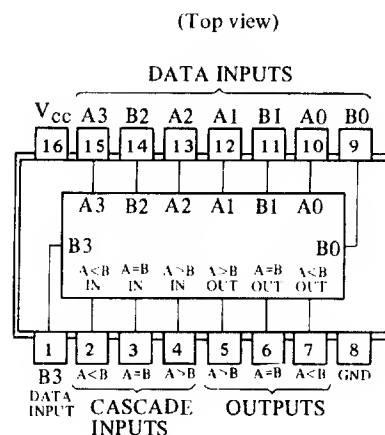
These four-bit magnitude comparators perform comparison of straight binary and straight BCD (8-4-2-1) codes. Three fully decoded decisions about two 4-bit words (A, B) are made and are externally available at three outputs. These devices are fully expandable to any number of bits without external gates. Words of greater length may be compared by connecting comparators in cascade. The A>B, A<B, and A=B output of a stage handling less-significant bits are connected to the corresponding A>B, A<B, and A=B inputs of the next stage handling more-significant bits.

Positive logic;

FUNCTION TABLES

| COMPARING INPUTS |       |       |       | CASCADING INPUTS |     |     | OUTPUTS |     |     |
|------------------|-------|-------|-------|------------------|-----|-----|---------|-----|-----|
| A3,B3            | A2,B2 | A1,B1 | A0,B0 | A>B              | A<B | A=B | A>B     | A<B | A=B |
| A3>B3            | X     | X     | X     | X                | X   | X   | H       | L   | L   |
| A3<B3            | X     | X     | X     | X                | X   | X   | L       | H   | L   |
| A3=B3            | A2>B2 | X     | X     | X                | X   | X   | H       | L   | L   |
| A3=B3            | A2<B2 | X     | X     | X                | X   | X   | L       | H   | L   |
| A3=B3            | A2=B2 | A1>B1 | X     | X                | X   | X   | H       | L   | L   |
| A3=B3            | A2=B2 | A1<B1 | X     | X                | X   | X   | L       | H   | L   |
| A3=B3            | A2=B2 | A1=B1 | A0>B0 | X                | X   | X   | H       | L   | L   |
| A3=B3            | A2=B2 | A1=B1 | A0<B0 | X                | X   | X   | L       | H   | L   |
| A3=B3            | A2=B2 | A1=B1 | A0=B0 | H                | L   | L   | H       | L   | L   |
| A3=B3            | A2=B2 | A1=B1 | A0=B0 | L                | H   | L   | L       | H   | L   |
| A3=B3            | A2=B2 | A1=B1 | A0=B0 | L                | L   | H   | L       | L   | H   |
| A3=B3            | A2=B2 | A1=B1 | A0=B0 | X                | X   | H   | L       | L   | H   |
| A3=B3            | A2=B2 | A1=B1 | A0=B0 | H                | H   | L   | L       | L   | L   |
| A3=B3            | A2=B2 | A1=B1 | A0=B0 | L                | L   | L   | H       | H   | L   |

H = high level L = low level X = irrelevant



(19) MB74LS86M (SN74LS86M)

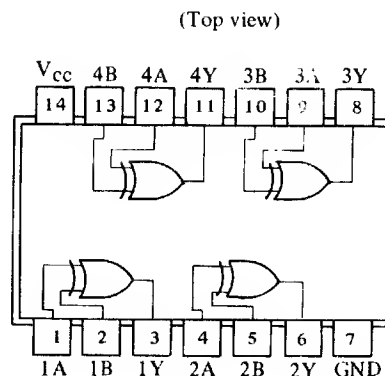
QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

Positive logic:  $Y = A + B = \overline{AB} + \overline{AB}$

FUNCTION TABLE

| INPUTS |   | OUTPUT |
|--------|---|--------|
| A      | B | Y      |
| L      | L | L      |
| L      | H | H      |
| H      | L | H      |
| H      | H | L      |

H = high level, L = low level

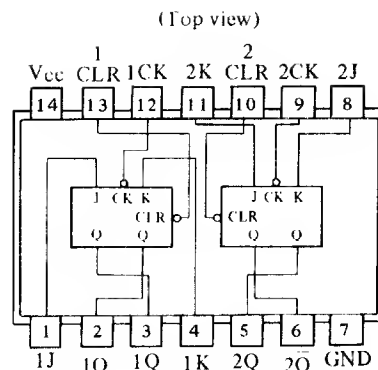


(20) MB74LS107M (SN74LS107N)  
DUAL J-K FLIP-FLOPS WITH CLEAR

positive logic;

FUNCTION TABLE

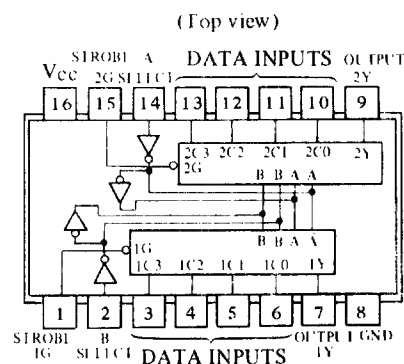
| INPUTS |       |   |   | OUTPUTS        |                |
|--------|-------|---|---|----------------|----------------|
| CLEAR  | CLOCK | J | K | Q              | Q̄             |
| L      | X     | X | X | L              | H              |
| H      | —     | L | L | Q <sub>0</sub> | Q <sub>0</sub> |
| H      | —     | H | L | H              | L              |
| H      | —     | L | H | L              | H              |
| H      | —     | H | H | TOGLE          | TOGLE          |



(21) MB74LS153N (SN74LS153N)  
S153  
QUAL 4-LINE-TO-1-LINE DATA SELECTORS/MULTIPLEXERS

- Permits Multiplexing from N lines to 1 line
- Performs Parallel-to-Serial Conversion
- Strobe (Enable) Line Provided for Cascading (N lines to n lines)

Each of these monolithic, data selectors/multiplexers contains inverters and drivers to supply fully complementary, on-chip, binary decoding data selection to the AND-OR-invert gates. Separate strobe inputs are provided for each of the two four-line sections.



functional block diagram

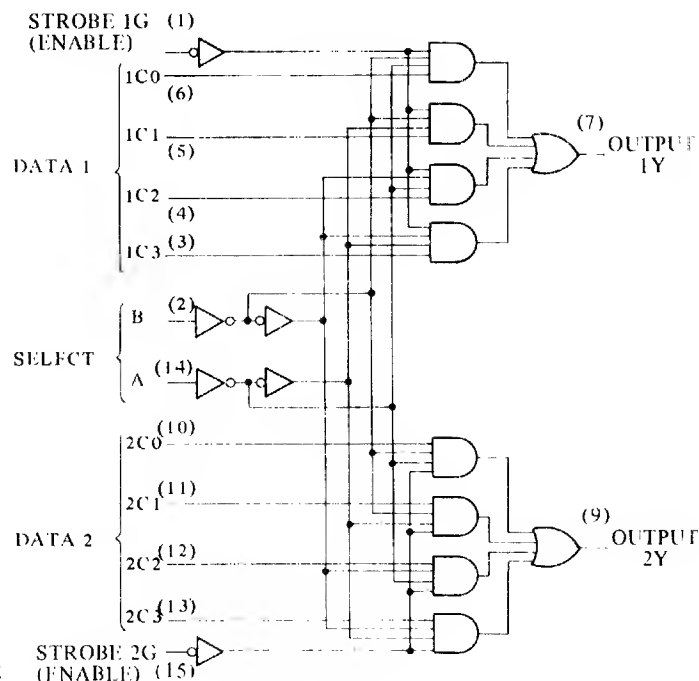
positive logic;

FUNCTION TABLE

| SELECT INPUTS |   | DATA INPUTS |    |    |    | STROBE | OUTPUT |
|---------------|---|-------------|----|----|----|--------|--------|
| B             | A | C0          | C1 | C2 | C3 | G      | Y      |
| X             | X | X           | X  | X  | X  | H      | L      |
| L             | L | L           | X  | X  | X  | L      | L      |
| L             | L | H           | X  | X  | X  | L      | H      |
| L             | H | X           | L  | X  | X  | L      | L      |
| L             | H | X           | H  | X  | X  | L      | H      |
| H             | L | X           | X  | L  | X  | L      | L      |
| H             | L | X           | X  | H  | X  | L      | H      |
| H             | H | X           | X  | X  | L  | L      | L      |
| H             | H | X           | X  | X  | H  | L      | H      |

Select inputs A and B are common to both sections.

H=high level, L=low level, X=irrelevant



(22) MB74LS155M (SN74LS155N)

## DUAL 2-LINE-TO-4-LINE DECODERS/DEMULTIPLEXERS

This monolithic transistor-transistor-logic (TTL) circuit features dual 1-line-to-4-line demultiplexers with individual strobes and common binary-address inputs in a single 16-pin package. When both sections are enabled by the strobes, the common binary-address inputs sequentially select and route associated input data to the appropriate output of each section. The individual strobes permit activating or inhibiting each of the 4-bit sections as desired. Data applied to input 10 is inverted at its outputs and data applied at 2C is not inverted through its outputs. The inverter following the 1C data input permits use as 3-to-8-line decoder or 1-to-8-line demultiplexer without external gating. Input clamping diodes are provided on all of these circuits to minimize transmission-line effects and simplify system design.

Positive logic;

FUNCTION TABLES  
2-LINE-TO-4-LINE DECODER  
OR 1-LINE-TO-4-LINE DEMULTIPLEXER

| INPUTS |   |        |      | OUTPUTS |     |     |     |
|--------|---|--------|------|---------|-----|-----|-----|
| SELECT |   | STROBE | DATA | 1Y0     | 1Y1 | 1Y2 | 1Y3 |
| B      | A | 1G     | 1C   |         |     |     |     |
| X      | X | H      | X    | H       | H   | H   | H   |
| L      | L | L      | H    | L       | H   | H   | H   |
| L      | H | L      | H    | H       | L   | H   | H   |
| H      | L | L      | H    | H       | H   | L   | H   |
| H      | H | L      | H    | H       | H   | H   | L   |
| X      | X | X      | L    | H       | H   | H   | H   |

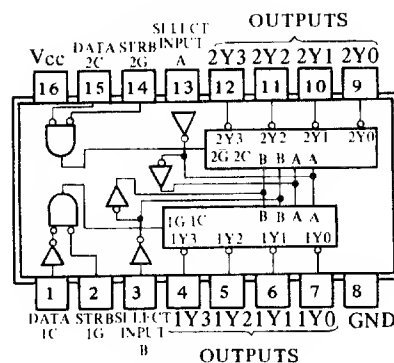
| INPUTS |   |        |      | OUTPUTS |     |     |     |
|--------|---|--------|------|---------|-----|-----|-----|
| SELECT |   | STROBE | DATA | 2Y0     | 2Y1 | 2Y2 | 2Y3 |
| B      | A | 2G     | 2C   |         |     |     |     |
| X      | X | H      | X    | H       | H   | H   | H   |
| L      | L | L      | L    | L       | H   | H   | H   |
| L      | H | L      | L    | H       | L   | H   | H   |
| H      | L | L      | L    | H       | H   | L   | H   |
| H      | H | L      | L    | H       | H   | H   | L   |
| X      | X | X      | H    | H       | H   | H   | H   |

FUNCTION TABLE  
3-LINE-TO-8-LINE DECODER  
OR 1-LINE-TO-8-LINE DEMULTIPLEXER

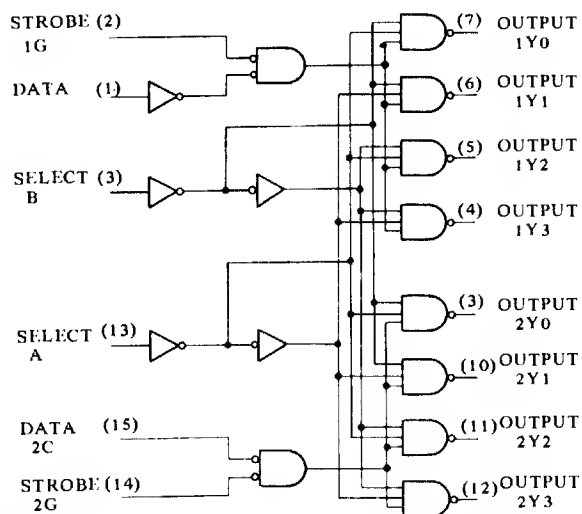
| INPUTS |   |                | OUTPUTS |     |     |     |     |     |     |     |
|--------|---|----------------|---------|-----|-----|-----|-----|-----|-----|-----|
| SELECT |   | STROBE OR DATA | (0)     | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| C†     | B | A              | 2Y0     | 2Y1 | 2Y2 | 2Y3 | 1Y0 | 1Y1 | 1Y2 | 1Y3 |
| X      | X | X              | H       | H   | H   | H   | H   | H   | H   | H   |
| L      | L | L              | L       | H   | H   | H   | H   | H   | H   | H   |
| L      | L | H              | H       | L   | H   | H   | H   | H   | H   | H   |
| L      | H | L              | H       | H   | L   | H   | H   | H   | H   | H   |
| L      | H | H              | H       | H   | H   | L   | H   | H   | H   | H   |
| H      | L | L              | H       | H   | H   | H   | L   | H   | H   | H   |
| H      | L | H              | H       | H   | H   | H   | H   | L   | H   | H   |
| H      | H | L              | H       | H   | H   | H   | H   | H   | L   | H   |
| H      | H | H              | H       | H   | H   | H   | H   | H   | H   | L   |

C = inputs 1C and 2C connected together, G = inputs 1G and 2G connected together  
H = high level, L = low level, X = irrelevant

(Top view)



functional block diagram and logic



(23) MB74LS161A (SN74LS161N)

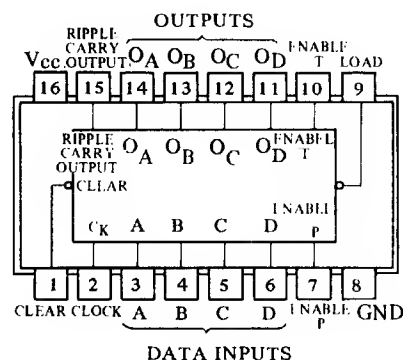
SYNCHRONOUS 4-BIT BINARY COUNTERSWITCH DIRECT CLEAR

This synchronous, presettable counters features an internal carry look-ahead for application in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes that are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

The counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function is asynchronous and a low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of clock, load, or enable inputs.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the  $Q_A$  output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. High-to-low-level transitions at the enable P or T inputs are allowed regardless of the level of the clock input.

It features a fully independent clock circuit. Changes at control inputs (enable P or T, or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable setup and hold times.



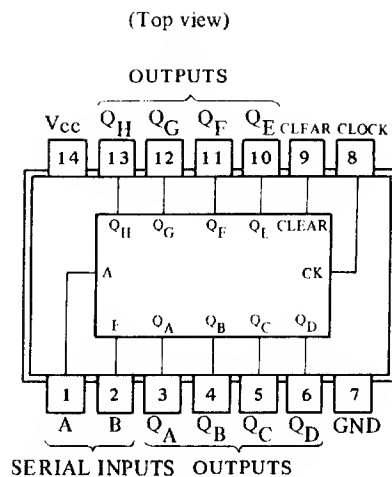
(Top view)

(24) MB74LS164M (SN74LS164N)

# 8-BIT PARALLEL-OUT SERIAL SHIFT REGISTERS

These 8-bit shift registers feature gated serial inputs and an asynchronous clear.

The gated serial inputs (A and B) permit complete control over incoming data as a low at either (or both) input(s) inhibits entry of the new data and resets the first flip-flop to the low level at the next clock pulse. A high-level input enables the other input which will then determine the state of the first flip-flop. Data at the serial inputs may be changed while the clock is high or low, but only information meeting the setup requirements will be entered. Clocking occurs on the low-to-high-level transition of the clock input. All inputs are diode-clamped to minimize transmission-line effects.



positive logic;

FUNCTION TABLE

| INPUTS |       |   |   | OUTPUTS         |                    |                 |
|--------|-------|---|---|-----------------|--------------------|-----------------|
| CLEAR  | CLOCK | A | B | Q <sub>A</sub>  | Q <sub>B</sub> ... | Q <sub>H</sub>  |
| L      | X     | X | X | L               | L                  | L               |
| H      | L     | X | X | Q <sub>AO</sub> | Q <sub>BO</sub>    | Q <sub>HO</sub> |
| H      | ↑     | H | H | H               | Q <sub>An</sub>    | Q <sub>Gn</sub> |
| H      | ↑     | L | X | L               | Q <sub>An</sub>    | Q <sub>Gn</sub> |
| H      | ↑     | X | L | L               | Q <sub>An</sub>    | Q <sub>Gn</sub> |

H = high level (steady state), L = low level (steady state)

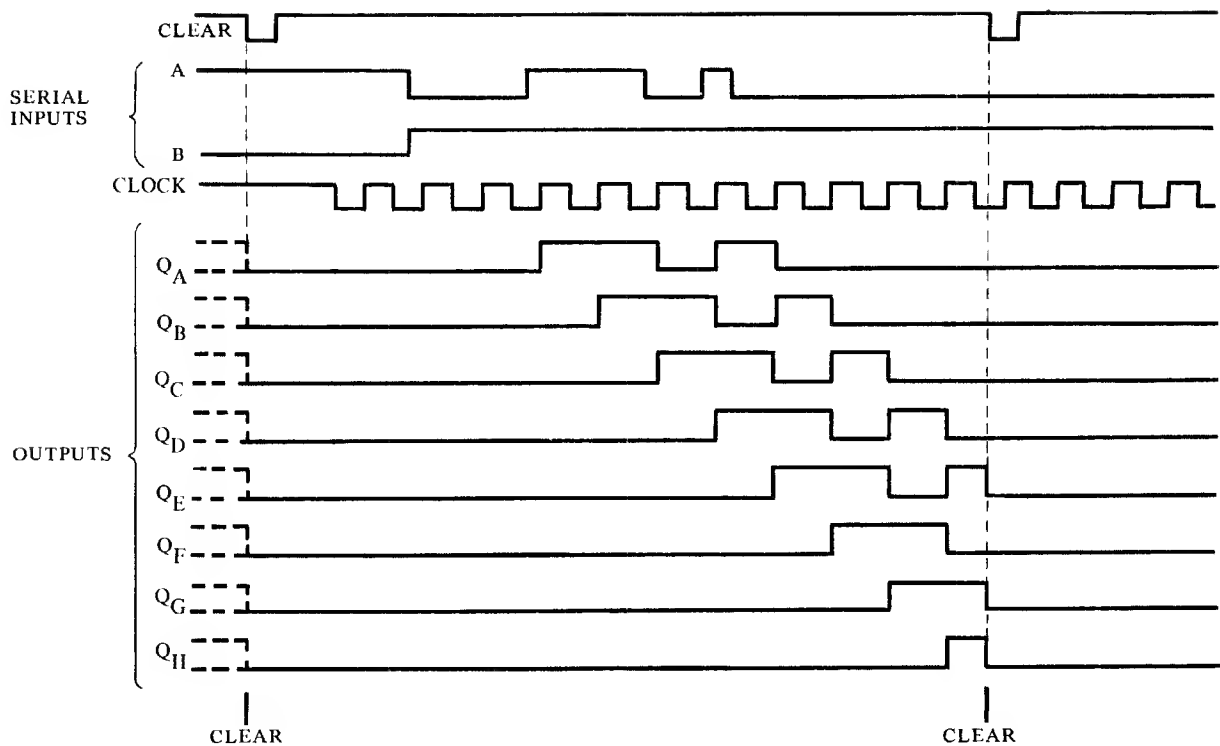
X = irrelevant (any input, including transitions)

↑ = transition from low to high level

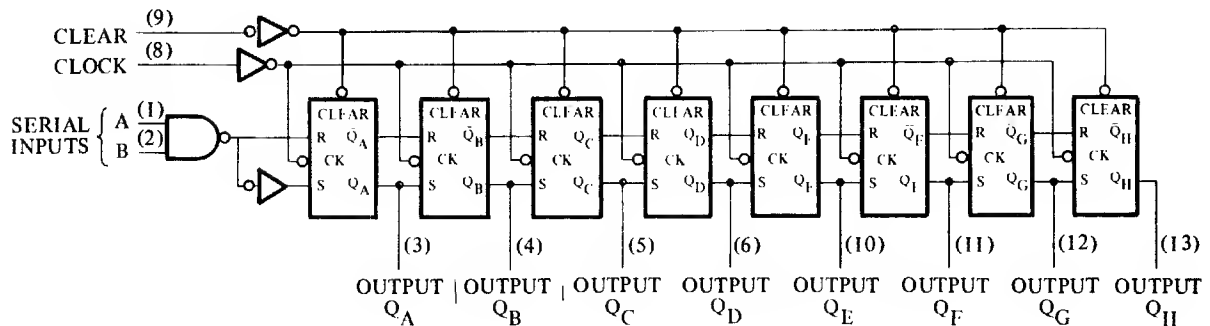
Q<sub>AO</sub>, Q<sub>BO</sub>, Q<sub>HO</sub> = the level of Q<sub>A</sub>, Q<sub>B</sub>, or Q<sub>H</sub>, respectively, before the indicated steady-state input conditions were established

Q<sub>An</sub>, Q<sub>Gn</sub> = the level of Q<sub>A</sub> or Q<sub>G</sub> before the most-recent ↑ transition of the clock; indicates a one-bit shift

typical clear, shift, and clear sequences



functional block diagram



(25) MB74LS191M (SN74LS191N)

SYNCHRONOUS 4-BIT UP/DOWN COUNTER

The LS191 is synchronous, reversible up/down counter having a complexity of 58 equivalent gates. Synchronous operation is provided by having all flipflops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

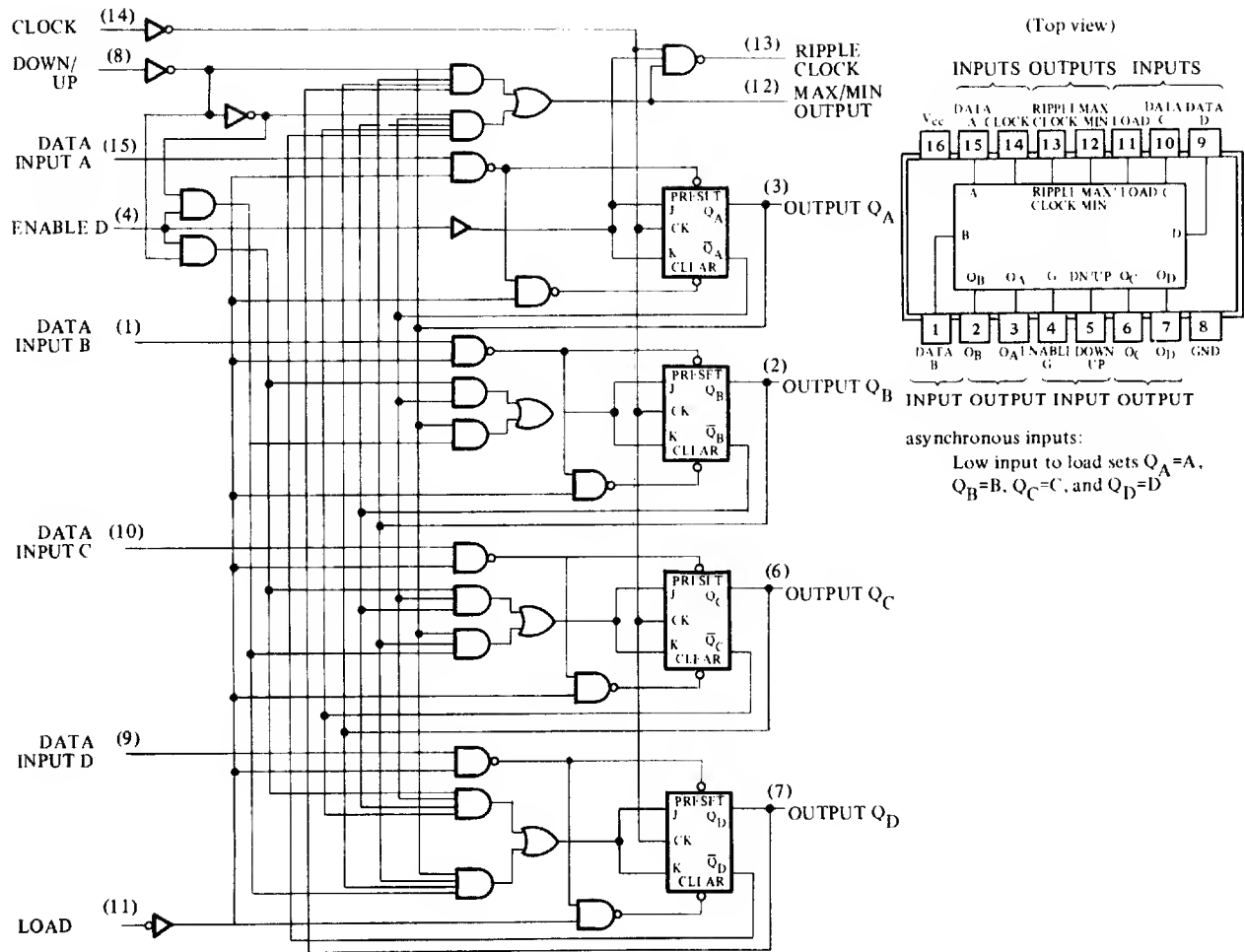
The outputs of the four master-slave flip-flops are triggered on a low-to-high-level transition of the clock input if the enable input is low. A high at the enable input inhibits counting. Level changes at the enable input should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down. Level changes at the down/up input should be made only when the clock input is high.

These counters are fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers simply modifying the count length with the preset inputs.

The clock, down/up, and load inputs are buffered to lower the drive requirement which significantly reduces the number of clock drivers, etc., required for long parallel words.

Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look ahead for high-speed operation.

positive logic:



(26) SN74LS279N

QUAD  $\overline{S}$ - $\overline{R}$  LATCHES

DIODE-CLAMPED INPUTS  
TOTEM-POLE OUTPUTS

FUNCTION TABLE

| INPUTS         |                | OUTPUT |
|----------------|----------------|--------|
| $\overline{S}$ | $\overline{R}$ | Q      |
| H              | J              | $Q_0$  |
| L              | H              | H      |
| H              | L              | L      |
| L              | L              | *      |

H = high level

L = low level

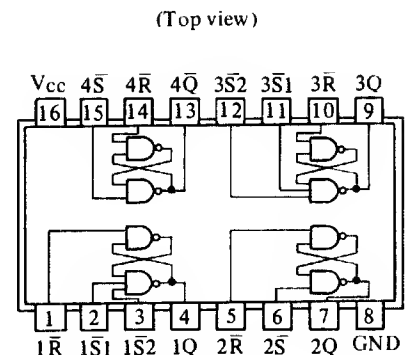
$Q_0$  = the level of Q before the indicated input conditions were established.

\* This output level is pseudo stable, that is, it may not persist when the  $\overline{S}$  and  $\overline{R}$  inputs return to their inactive (high) level.

For latches with double  $\overline{S}$  input.

H = both  $\overline{S}$  input high

L = one or both  $\overline{S}$  inputs low





(27) MB74LS283M (LN74LS283M)

# 4-BIT BINARY FULL ADDER

This full adder performs the addition of two 4-bit binary words. The sum ( $\Sigma$ ) outputs are provided for each bit and the resultant carry ( $C_4$ ) is obtained from the fourth bit. These address feature full internal look-ahead across all four bits generating the carry term in ten nano-seconds typically. This capability provides the system designer with partial look-ahead performance at the economy and reduced package count of a ripple-carry implementation.

The adder logic, including the carry, is implemented in its true form. End around carry can be accomplished without the need for logic or level inversion.

positive logic;

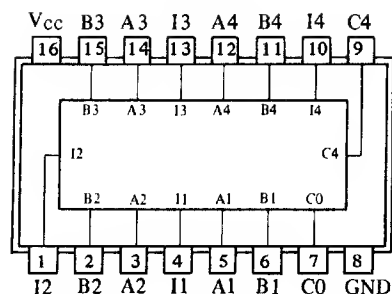
FUNCTION TABLE

| INPUT    |          |          |          | OUTPUT                   |                          |          |                          |                          |          |
|----------|----------|----------|----------|--------------------------|--------------------------|----------|--------------------------|--------------------------|----------|
|          |          |          |          | WHEN<br>CO-L             |                          |          | WHEN<br>CO-H             |                          |          |
|          |          |          |          | WHEN<br>C2-L             |                          |          | WHEN<br>C2-H             |                          |          |
| A1<br>A3 | B1<br>B3 | A2<br>A4 | B2<br>B4 | $\Sigma 1$<br>$\Sigma 3$ | $\Sigma 2$<br>$\Sigma 4$ | C2<br>C4 | $\Sigma 1$<br>$\Sigma 3$ | $\Sigma 2$<br>$\Sigma 4$ | C2<br>C4 |
| L        | L        | L        | L        | L                        | L                        | L        | H                        | L                        | L        |
| H        | L        | L        | L        | H                        | L                        | L        | L                        | H                        | L        |
| L        | H        | L        | L        | H                        | L                        | L        | L                        | H                        | L        |
| H        | H        | L        | L        | L                        | H                        | L        | H                        | H                        | L        |
| L        | L        | H        | L        | L                        | H                        | L        | H                        | H                        | L        |
| H        | L        | H        | L        | H                        | H                        | L        | L                        | L                        | H        |
| L        | H        | H        | L        | H                        | H                        | L        | L                        | L                        | H        |
| H        | H        | H        | L        | L                        | L                        | H        | H                        | L                        | H        |
| L        | L        | L        | H        | L                        | H                        | L        | H                        | H                        | L        |
| H        | L        | L        | H        | H                        | H                        | L        | L                        | L                        | H        |
| L        | H        | L        | H        | H                        | L                        | H        | H                        | L                        | H        |
| H        | H        | L        | H        | L                        | L                        | H        | H                        | L                        | H        |
| L        | L        | H        | H        | L                        | L                        | H        | H                        | L                        | H        |
| H        | L        | H        | H        | H                        | L                        | H        | L                        | H                        | H        |
| L        | H        | H        | H        | H                        | L                        | H        | L                        | H                        | H        |
| H        | H        | H        | H        | L                        | H                        | H        | H                        | H                        | H        |

H = high level, L = low level

NOTE: Input conditions at A1, B1, A2, B2, and C0 are used to determine outputs  $\Sigma 1$  and  $\Sigma 2$  and the value of the internal carry C2. The values at C2, A3, B3, A4, and B4 are then used to determine outputs  $\Sigma 3$ ,  $\Sigma 4$ , and C4.

(Top view)



(28) MB440M (SN74123)  
SN74LS123N

# DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATORS

This monolithic TTL retriggerable monostable multivibrator features d-c triggering from gated low-level-active (A) and high-level-active (B) inputs, and also provides overriding direct clear inputs. The retrigger capability simplifies the generation of output pulses of extremely long duration. By triggering the input before the output pulse terminated, the output pulse may be extended. The overriding clear capability permits any output pulse to be terminated at a predetermined time independently of the timing components R and C. The output pulse is primarily a function of the external capacitor and resistor.

For Cext 1000pF, the output pusle width (tw) is defined as:

$$tw = 0.32RtCext \left(1 + \frac{0.7}{Rt}\right)$$

tw : ns

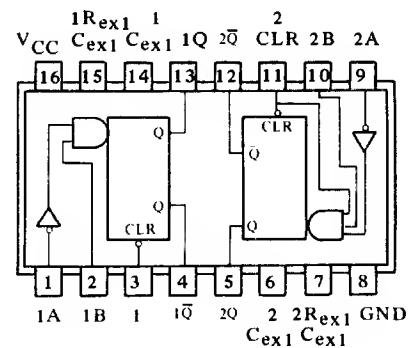
Rt : kohms

Cext : pF

FUNCTION TABLE

| INPUTS |   |   | OUTPUTS |                |
|--------|---|---|---------|----------------|
| CLEAR  | A | B | Q       | $\overline{Q}$ |
| L      | X | X | L       | H              |
| X      | H | X | L       | H              |
| X      | X | L | L       | H              |
| H      | L | ↑ | ⌋       | ⌋              |
| H      | ↓ | H | ⌋       | ⌋              |
| ↑      | L | H | ⌋       | ⌋              |

(Top view)



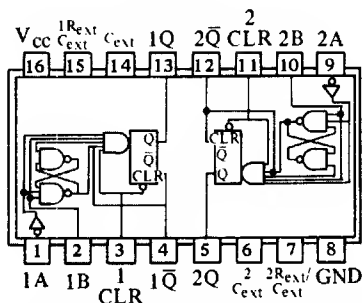
(29) SN74LS221N  
SN74221N

# DUAL MONOSTABLE MULTIVIBRATORS

The SN74LS221N and SN74221N are monolithic dual multivibrators. Each multivibrator features a negative-transition-triggered input and a posi-ive-transition-triggered input either of which can be used as an inhibit input.

Pulse triggering occurs at a particular voltage level and is not directly related to the transition time of the input pulse. Schmitt-trigger input circuitry (TTL hysteresis) for B input allows jitter-free triggering from inputs with transition rates as slow as 1 volt/second, providing the circuit with excellent noise immunity of typically 1.2 volts. A high immunity to Vcc noise of typically 1.5 volts is also provided by internal latching circuitry.

(Top view)



Positive logic: Low input to clear resets Q low and  $\bar{Q}$  high regardless of d-c levels at A or B inputs.

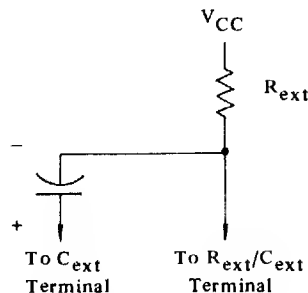
FUNCTION TABLE  
(EACH MONOSTABLE)

| INPUTS     |              |   | OUTPUTS |           |
|------------|--------------|---|---------|-----------|
| CLEAR      | A            | B | Q       | $\bar{Q}$ |
| L          | X            | X | L       | H         |
| X          | H            | X | L       | H         |
| X          | X            | L | L       | H         |
| H          | L            | O |         |           |
| H          | $\downarrow$ | H |         |           |
| $\uparrow$ | L            | H |         |           |

The output pulse width (tw) defined as:

$$tw = 0.7R_{ext}C_{ext}$$

tw ; ns, rext : kohms, Cext : pf

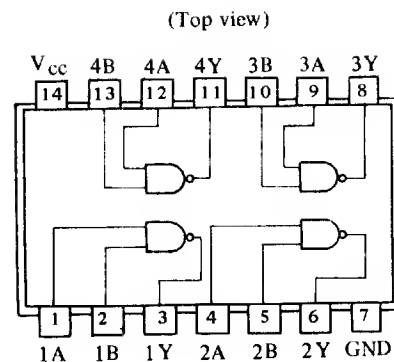


TIMING COMPONENT CONNECTIONS

(30) MB463M (SN7438N)

QUADRUPLE 2-INPUT  
POSITIVE-NAND BUFFERS  
WITH OPEN-COLLECTOR OUTPUTS

positive logic:  $Y = \overline{AB}$



(31) MB434M (SN75451BP)

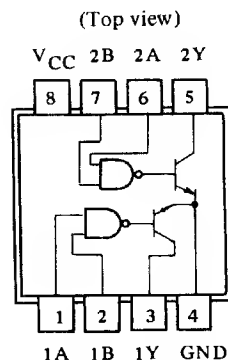
DUAL PERIPHERAL POSITIVE-AND DRIVERS

positive logic:  $Y = AB$

FUNCTION TABLE  
(EACH DRIVER)

| A | B | Y             |
|---|---|---------------|
| L | L | L (on state)  |
| L | H | L (on state)  |
| H | L | L (on stage)  |
| H | H | H (off state) |

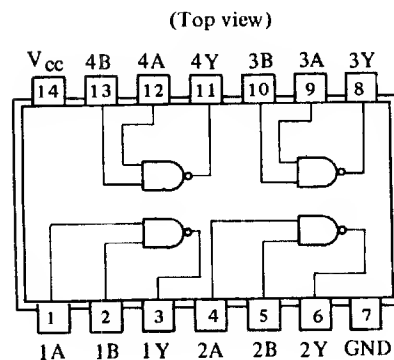
H=high level, L=low level



(32) MB435M (SN7437N)

QUADRUPLE 2-INPUT  
POSITIVE-NAND BUFFERS

positive logic:  $Y = \overline{AB}$



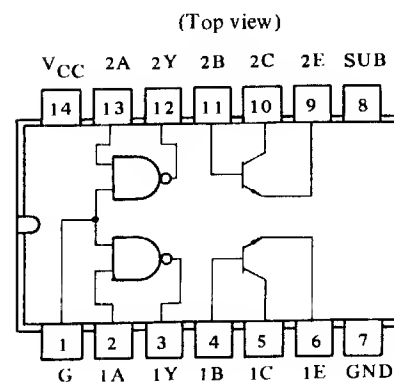
(33) MB439M (SN75450BN)

DUAL PERIPHERAL POSITIVE-AND DRIVERS

positive logic:

$Y = \overline{AG}$  (gate only)

C = AG (gate and transistor)



## BCD-TO-DECIMAL DECODERS/DRIVERS

This monolithic BCD-to-decimal decoder/drivers consists of eight inverters and ten four-input NAND gates. The inverters are connected in pairs to make BCD input data available for decoding by the NAND gates. Full decoding of valid BCD input logic endures that all outputs remain off for all invalid binary input conditions. These decoders feature high-performance, n-p-n output transistors designed for use as indicator/relay drivers or as spen-collector logic-circuit drivers. Each of the high-breakdown output transistors (15 volts) will sink up to 80 milliamperes of current. Inputs and outputs are entirely compatible for use with TTL or DTL logic circuits, and the outputs are compatible for interfacing with most MOS integrated circuits.

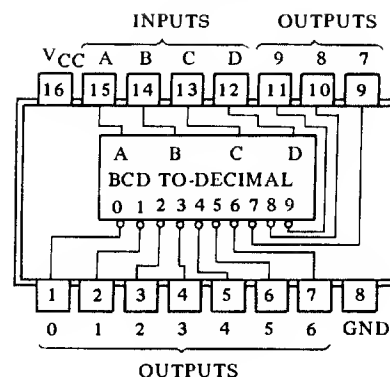
Positive logic

FUNCTION TABLE

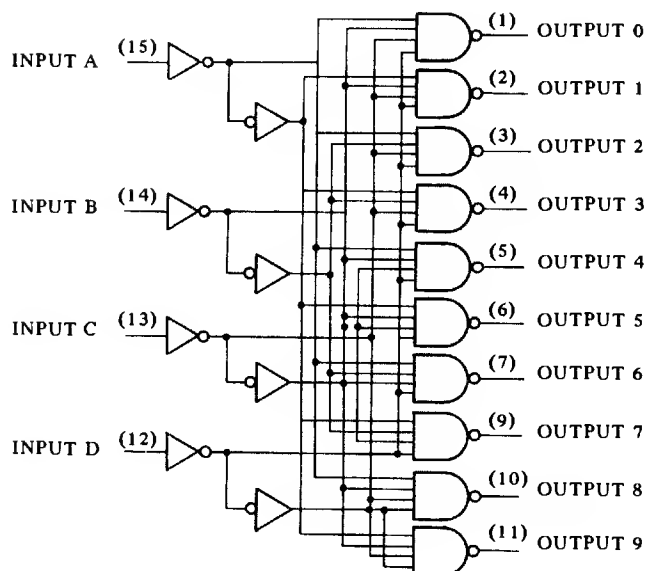
| No.     | INPUTS |   |   |   | OUTPUTS |   |   |   |   |   |   |   |   |   |
|---------|--------|---|---|---|---------|---|---|---|---|---|---|---|---|---|
|         | D      | C | B | A | 0       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0       | L      | L | L | L | L       | H | H | H | H | H | H | H | H | H |
| 1       | L      | L | L | H | H       | L | H | H | H | H | H | H | H | H |
| 2       | L      | L | H | L | H       | H | L | H | H | H | H | H | H | H |
| 3       | L      | L | H | H | H       | H | H | L | H | H | H | H | H | H |
| 4       | L      | H | L | L | H       | H | H | H | L | H | H | H | H | H |
| 5       | L      | H | L | H | H       | H | H | H | H | L | H | H | H | H |
| 6       | L      | H | H | L | H       | H | H | H | H | H | L | H | H | H |
| 7       | L      | H | H | H | H       | H | H | H | H | H | H | L | H | H |
| 8       | H      | L | L | L | H       | H | H | H | H | H | H | H | L | H |
| 9       | H      | L | L | H | H       | H | H | H | H | H | H | H | H | L |
| INVALID | H      | L | H | L | H       | H | H | H | H | H | H | H | H | H |
|         | H      | L | H | H | H       | H | H | H | H | H | H | H | H | H |
|         | H      | H | L | L | H       | H | H | H | H | H | H | H | H | H |
|         | H      | H | L | H | H       | H | H | H | H | H | H | H | H | H |
|         | H      | H | H | L | H       | H | H | H | H | H | H | H | H | H |
|         | H      | H | H | H | H       | H | H | H | H | H | H | H | H | H |

H = high level (off),  
L = low level (on)

(Top view)



functional block diagram



(35) SN74193

# SYNCHRONOUS 4-BIT BINARY UP/DOWN COUNTERS (DUAL CLOCK WITH CLEAR)

Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidentally with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple-clock) counters.

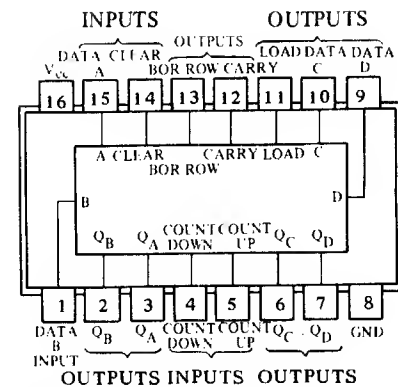
The outputs of the four master-slave flip-flops are triggered by a low-to-high-level transition of either count

(clock) input. The direction of counting is determined by which count input is pulsed while the other count input is high.

All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the data inputs while the load input is low. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

A clear input has been provided which forces all outputs to the low level when a high level is applied. The clear function is independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements. This reduces the number of clock drivers, etc., required for long words.

These counters were designed to be cascaded without the need for external circuitry. Both borrow and carry outputs are available to cascade both the up- and down-counting functions. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-up input when an overflow condition exists. The counters can then be easily cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding counter.



(Top view)

logic: Low input to load sets  $Q_A = A$ ,  
 $Q_R = B$ ,  $Q_C = C$ , and  $Q_D = D$

(36) SN75452

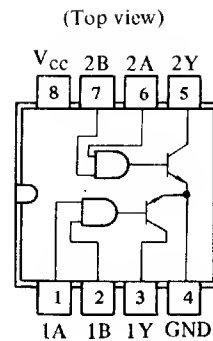
# DUAL PERIPHERAL POSITIVE-NAND DRIVERS

positive logic:  $Y = \overline{AB}$

FUNCTION TABLE  
(EACH DRIVER)

| A | B |               |
|---|---|---------------|
| L | L | H (off state) |
| L | H | H (off state) |
| H | L | H (off state) |
| H | H | L (on state)  |

H = high level, L = low level



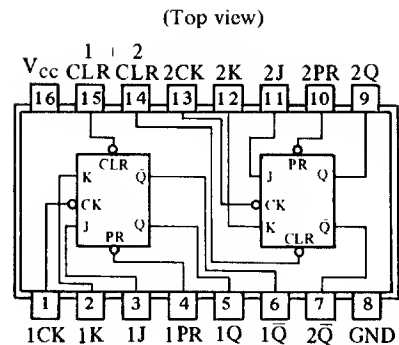
(37) SN74S112N

# DUAL J-K ENGATEVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

positive logic;

FUNCTION TABLE

| INPUTS |       |       |   |   | OUTPUTS        |                |
|--------|-------|-------|---|---|----------------|----------------|
| PRESET | CLEAR | CLOCK | J | K | Q              | $\overline{Q}$ |
| L      | L     | X     | X | X | H              | L              |
| H      | L     | X     | X | X | L              | H              |
| L      | L     | X     | X | X | H*             | H*             |
| H      | H     | ↓     | L | L | Q <sub>0</sub> | Q <sub>0</sub> |
| H      | H     | ↓     | H | L | H              | L              |
| H      | H     | ↓     | L | H | L              | H              |
| H      | H     | ↓     | H | H | TOGGLE         |                |
| H      | H     | H     | X | X | Q <sub>0</sub> | Q <sub>0</sub> |



(38) SN75107AN  
SN75108AN

#### DUAL LINE RECEIVERS

The 107A, and 108A line receivers are TTL-compatible dual circuits intended for use in high-speed data-transmission systems. They are designed to detect low-level differential signals in the presence of common-mode noise and variations of temperature and supplies. Dc specifications reflect worst-case conditions of temperature, supply voltages, and input voltages.

These receivers feature independent channels with common voltage supply and ground terminals. The 107A features TTL-compatible active pull-up (totem-pole) outputs. The 108A is also TTL-compatible, but features an open-collector output configuration that permits the wired-AND logic connection with similar outputs. This permits a level of logic to be implemented without extra delay.

The input common-mode voltage range is  $\pm 3$  volts. This is adequate for application in most systems. In systems with requirements for greater common-mode voltage range, input attenuators may be used to decrease the noise to an acceptable level at the receiver-input terminals.

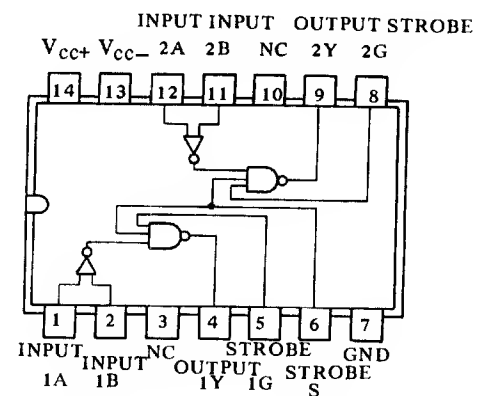
The receivers feature individual strobe inputs for each channel and a strobe input common to both channels for logic versatility. The strobe inputs are tested to guarantee 400 millivolts of dc noise margin when interfaced with Series 54/74 TTL.

The circuits feature high input impedance and low input currents, which induce very little loading on the transmission line. This makes these devices especially useful in party-line systems. The excellent input sensitivity is particularly important when data is to be detected at the end of a long transmission line and the amplitude of the data has deteriorated due to cable losses. These line receivers are designed to detect input signals of 25 millivolts (or greater) amplitude and convert the polarity of the signal into appropriate TTL-compatible output logic levels.

FUNCTION TABLE

| DIFFERENTIAL<br>INPUTS<br>A-B         | STROBES |   | OUTPUT<br>Y   |
|---------------------------------------|---------|---|---------------|
|                                       | G       | S |               |
| $V_{ID} > 25\text{mV}$                | X       | X | H             |
| $-25\text{mV} < V_{ID} < 25\text{mV}$ | X       | L | H             |
|                                       | L       | X | H             |
|                                       | H       | H | INDETERMINATE |
| $V_{ID} < -25\text{mV}$               | X       | L | H             |
|                                       | L       | X | H             |
|                                       | H       | H | L             |

H = high level, L = low level,  
X = irrelevant



NC—No internal connection

(Top view)



(39) SN75110A

DUAL LINE DRIVERS

These drivers feature independent channels with common voltage supply and ground terminals. The driver circuits feature a constant output current that is switched to either of two output terminals by the appropriate logic levels at the input terminals. The output current can be switched off (inhibited) by low logic levels on the inhibit inputs. The output current is nominally 12 milliamperes.

The inhibit feature is provided so the circuits can be used in party-line or data-bus applications. Astrobe or inhibitor, common to both drivers, is included for increased driver-logic versatility. The output current in the inhibited mode,  $I_{O(off)}$ , is specified so that minimum line loading is induced when the driver is used in a party-line system with other drivers. The output impedance of the driver in the inhibited mode is very high—the output impedance of a transistor biased to cutoff.

The driver outputs have a common-mode voltage range of -3 volts to 10 volts, allowing common-mode voltage on the line without affecting driver performance.

FUNCTION TABLE

| LOGIC INPUTS |   | INHIBITOR INPUTS |   | OUTPUTS |     |
|--------------|---|------------------|---|---------|-----|
| A            | B | C                | D | Y       | Z   |
| X            | X | L                | X | OFF     | OFF |
| X            | X | X                | L | OFF     | OFF |
| L            | X | H                | H | ON      | OFF |
| X            | L | H                | H | ON      | OFF |
| H            | H | H                | H | OFF     | ON  |

H = high level, L = low level,  
X = irrelevant

(40) MB15139C

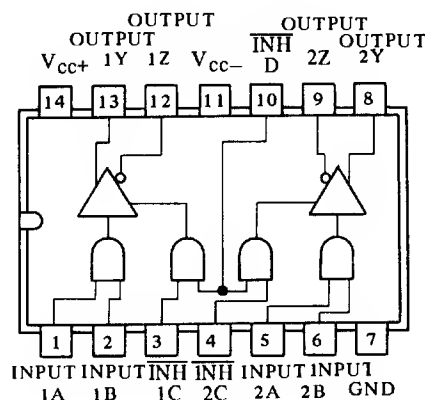
ACCESS CONTROL

This Bipolar 500-Gate LSI has features to control and check the rezero and seek operation of disk drive.

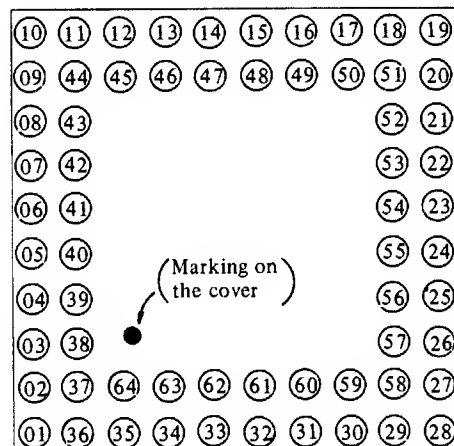
Package; 64-pin RIT

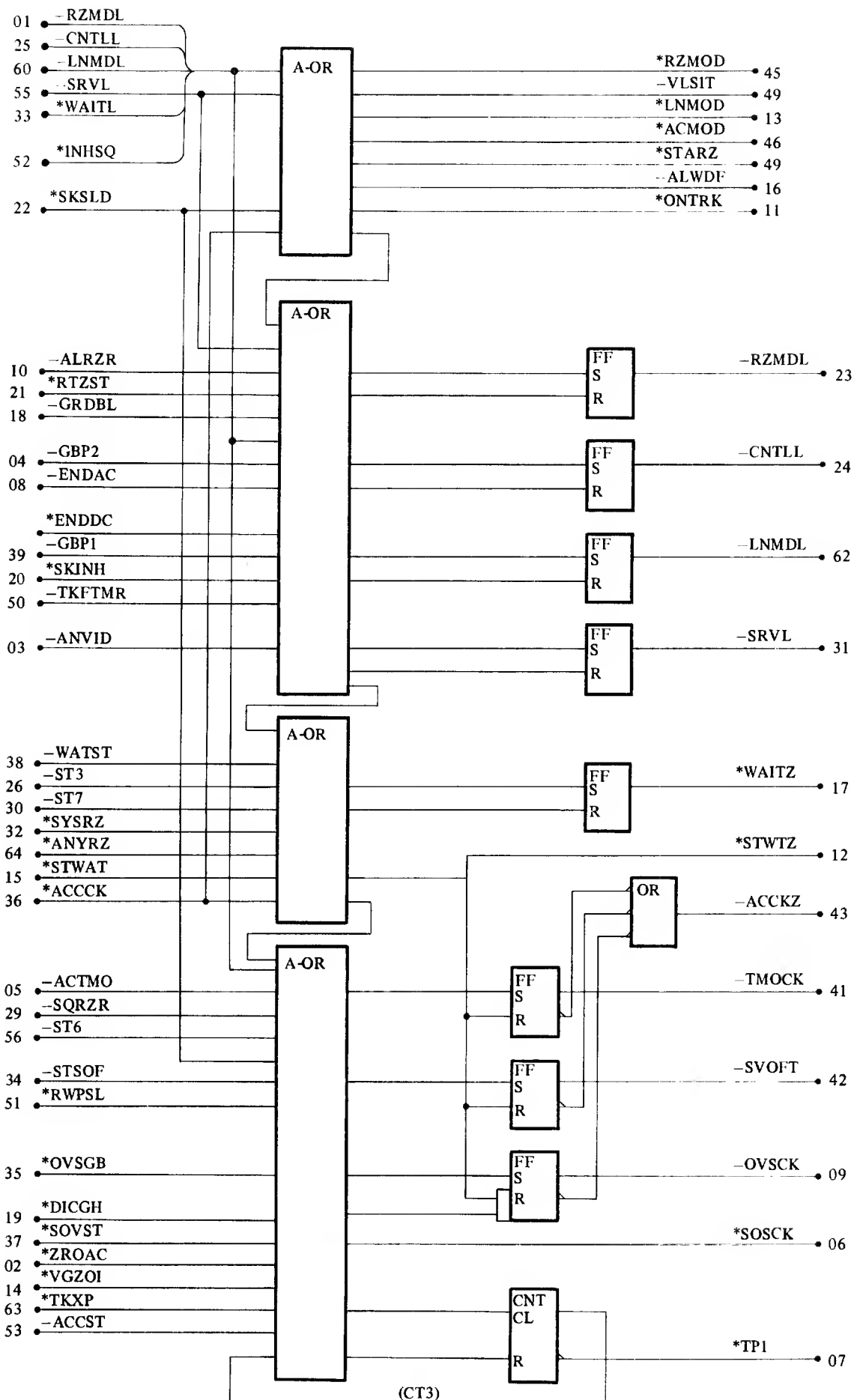
Pin-  
+5V; 47, 61  
0V; 40, 54

(Top view)



(Bottom view)





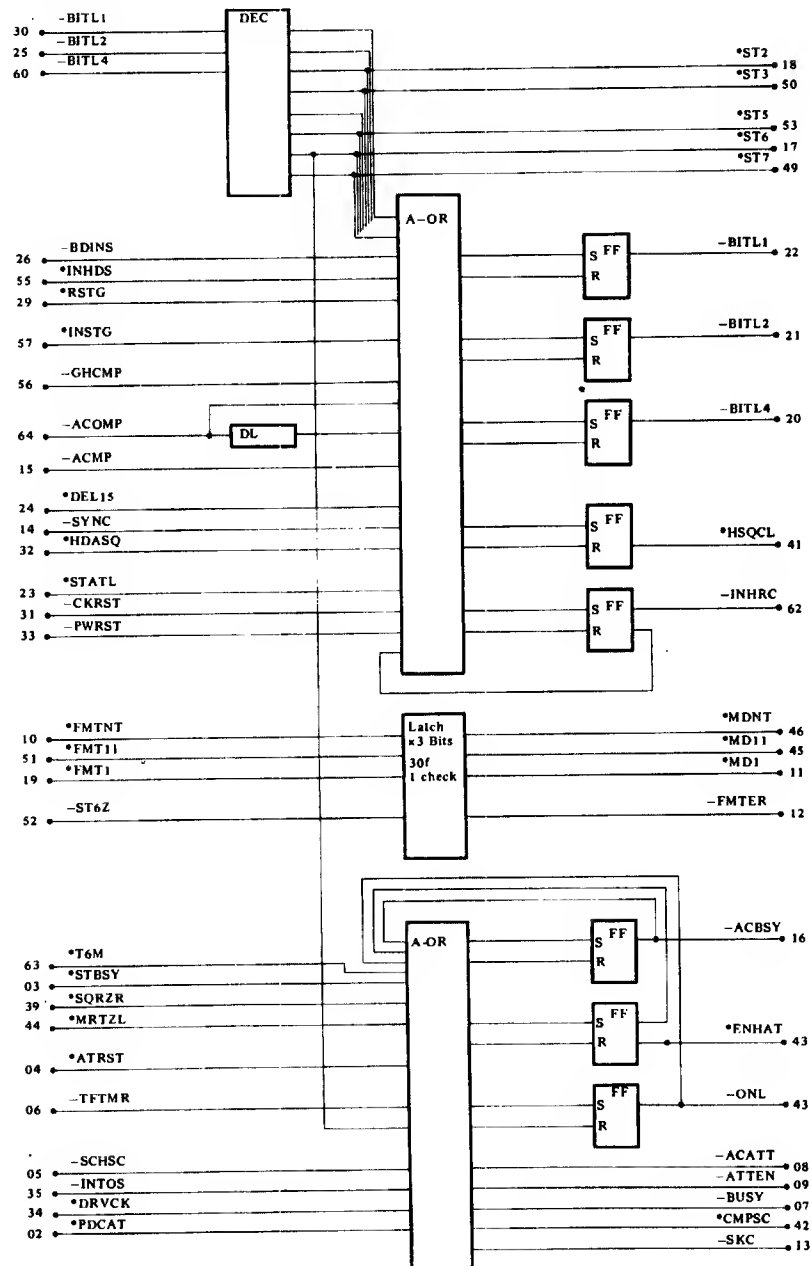
(41) MB15140C  
HDA SEQUENCER

This Bipolar 500-Gate LSI has the following functions when used in the disk drive.

- Sequence control of spindle motor
- Generation of machine status information

Package ; 64-pin, RIT

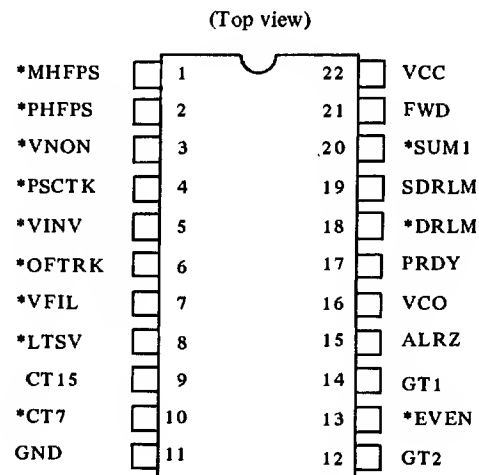
functional block diagram



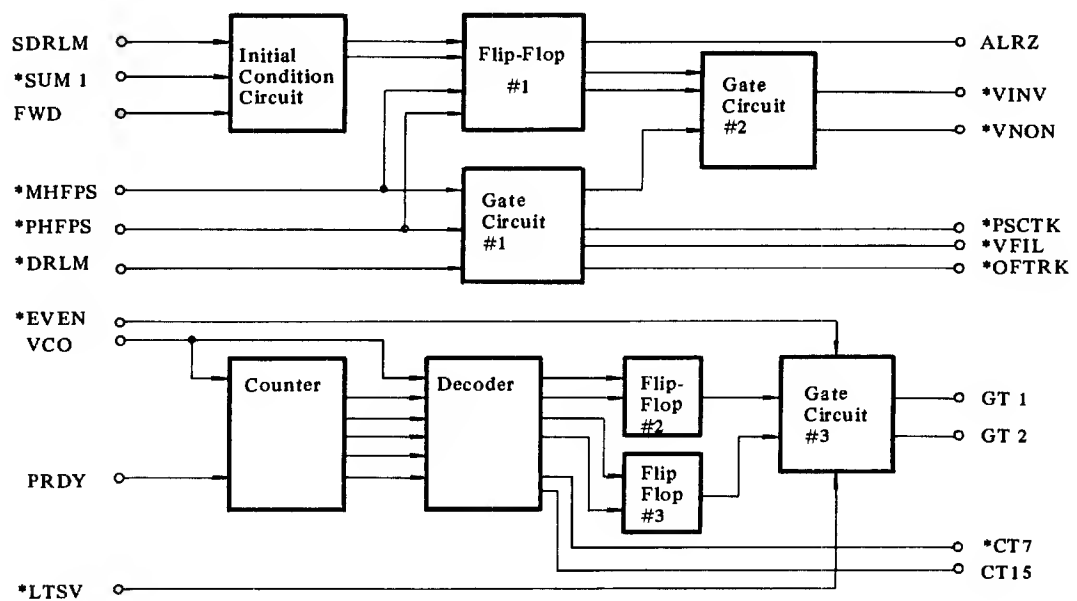
(42) MB14601C

# LINEAR MOTOR CONTROL

This Bipolar 200-Gate LSI generates gating signals to sense both the position signal and the velocity signal. The position logic portion in the IC forms a PLL circuit in conjunction with a VCO. The velocity logic portion contains a polarity check circuit and a gate signal generator for velocity signal demodulation.



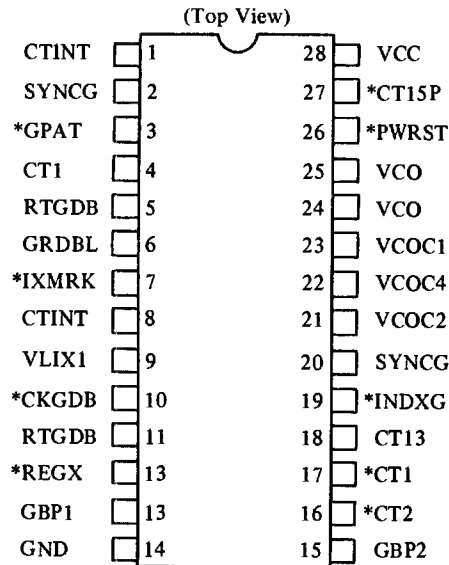
## functional block diagram



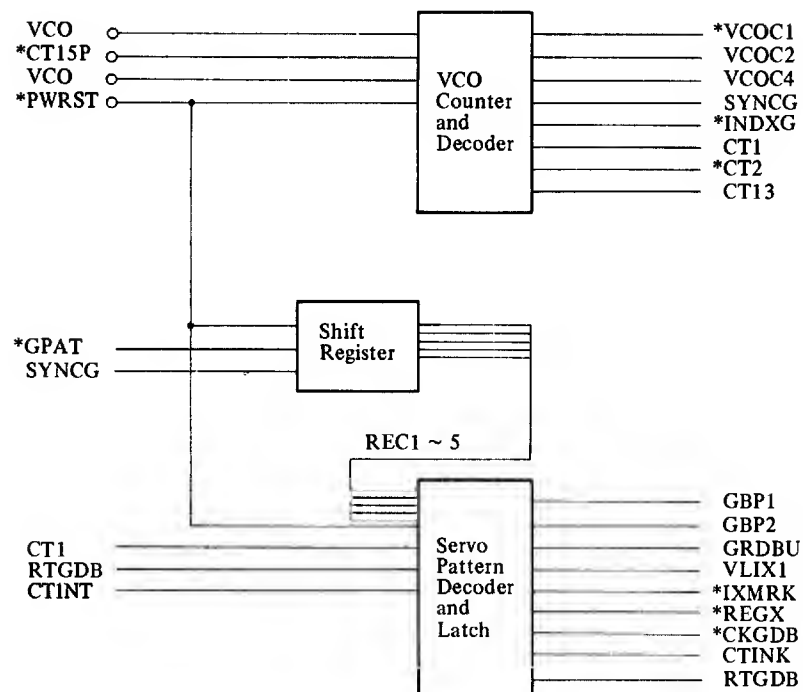
(4.3) MB14613C

### Servo Pattern Detector

This circuit identifies the Servo Patterns and detects guard band 1, guard band 2, index and the outer guard band.

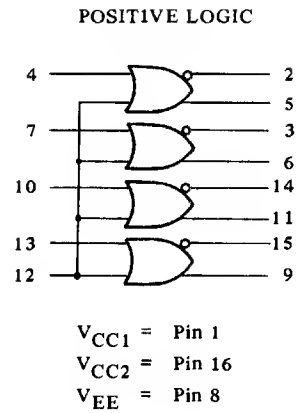


functional block diagram



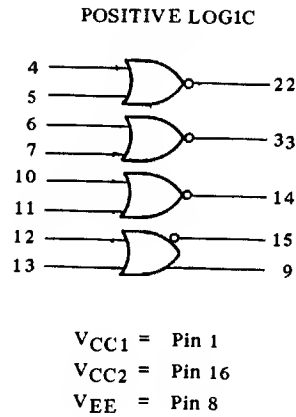
(44) MB10101C (MC10101)

QUAD 2-INPUT OR/NOR GATES



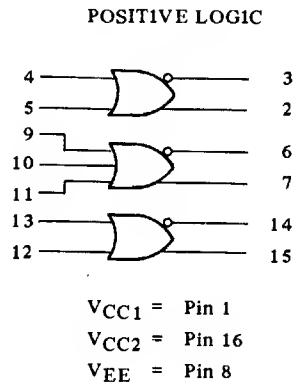
(45) MB10102C (MC10102)

QUAD 2-INPUT NOR GATES



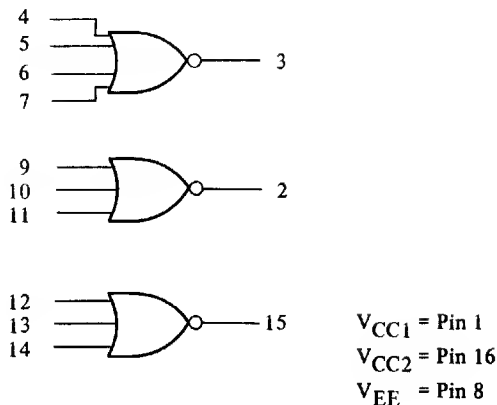
(46) MB10105C (MC10105)

TRIPLE 2-3-2 INPUT OR/NOR GATES



(47) MB10106C (MC10106)

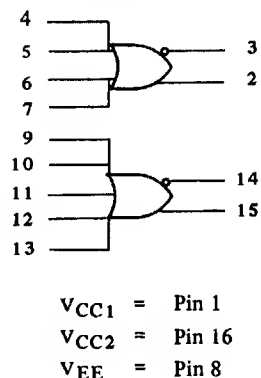
TRIPLE 4-3-3 NOR GATES



(48) MB10109 (MC10109)

DUAL 4-5 INPUT OR/NOR GATES

POSITIVE LOGIC



(49) MB10116 (MC10116)

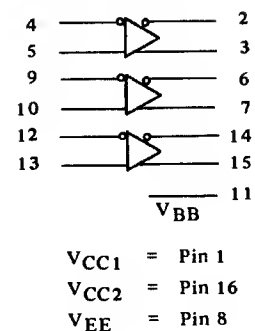
TRIPLE LINE RECEIVERS

The MC10116 is a triple differential amplifier designed for use in sensing differential signals over long lines. The base bias supply ( $V_{BB}$ ) is made available at pin 11 to make the device useful as a Schmitt trigger, or in other applications where a stable reference voltage is necessary.

Active current sources provide the MC10116 with excellent common mode noise rejection. If any amplifier in a package is not used, one input of that amplifier must be connected to  $V_{BB}$  (pin 11) to prevent upsetting the current source bias network.

Complementary outputs are provided to allow driving twisted pair lines, to enable cascading of several amplifiers in a chain, or simply to provide complement outputs of the input function.

POSITIVE LOGIC



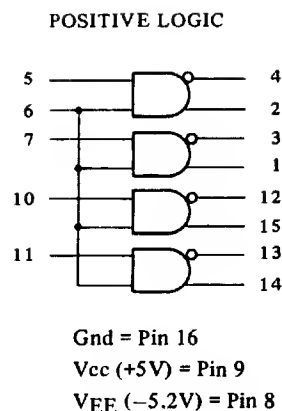
(50) MB10124 (MC10124)

QUAD MTTL TO MECL TRANSLATORS

The MC10124 is a quad translator for interfacing data and control signals between a saturated logic section and the MECL section of digital systems. The MC10124 has MTTL compatible inputs, and MECL complementary open-emitter outputs that allow use as an inverting/non-inverting translator or as a differential line driver. When the common strobe input is at the low logic level, it forces all true outputs to a MECL low logic state and all inverting outputs to a MECL high logic state.

Power supply requirements are ground, +5.0 Volts, and -5.2 Volts. Propagation delay of the MC10124 is typically 3.5 ns. The dc levels are standard or Schottky TTL in MECL 10,000 out.

An advantage of this device is that MTTL level information can be transmitted differentially, via balanced twisted pair lines, to the MECL equipment, where the signal can be received by the MC10115 or MC10116 differential line receivers. The MC10124 is useful in computers, instrumentation, peripheral controllers, test equipment, and digital communications systems.



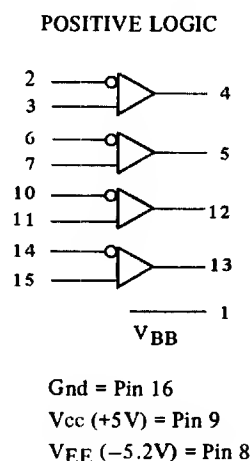
(51) MB10124 (MC10125)

QUAD MECL TO MTTL TRANSLATORS

The MC10125 is a quad translator for interfacing data and control signals between the MECL section and saturated logic sections of digital systems. The MC10125 incorporates differential inputs and Schottky MTTL "totem pole" outputs. Differential inputs allow for use as an inverting/non-inverting translator or as a differential line receiver. The  $V_{BB}$  reference voltage is available on pin 1 for use in single-ended input biasing. The outputs of the MC10125 go to a low logic level whenever the inputs are left floating.

Power supply requirements are ground, +5.0 Volts and 05.2 Volts. Propagation delay of the MC10125 is typically 4.5 ns. The MC10125 has fanout of 10 MTTL loads. The dc levels are MECL 10,000 in and Schottky TTL, or MTTL out. This device has an input common mode noise rejection of  $\pm 1.0$  Volt.

An advantage of this device is that MECL level information can be received, via balanced twisted pair lines, in the MTTL equipment. This isolates the MECL logic from the noisy MTTL environment. This device is useful in computers, instrumentation, peripheral controllers, test equipment and digital communications systems.



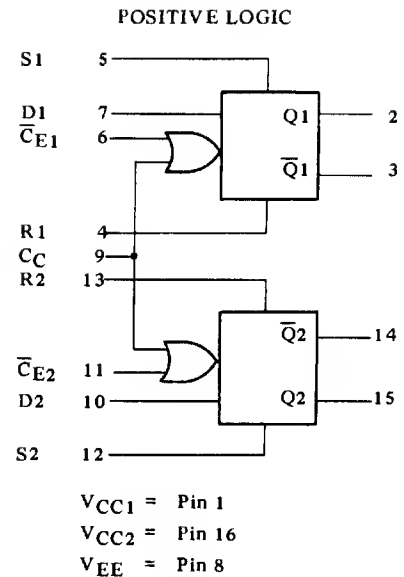


## DUAL D-TYPE MASTER-SLAVE FLIP-FLOPS

The MC10131 is a dual master-slave type D flip-flop. Asynchronous Set (S) and Reset (R) override Clock ( $C_C$ ) and Clock Enable ( $C_E$ ) input. Each flip-flop may be clocked Separately by holding the common clock in the low state and using the enable inputs for the clocking function. If the common clock is to be used to clock the flip-flop, the Clock Enable inputs must be in the low state. In this case, the enable inputs perform the function of controlling the common clock.

The output states of the flip-flop change on the positive transition of the clock. A change in the information present at the data (D) input will not affect the output information at any other time due to master slave construction.

Input pulldown resistors eliminate the need to tie unused inputs to  $V_{EE}$ . Output rise and fall times have been optimized to provide relaxation of system design and layout criteria.



RS TRUTH TABLE

| R | S | $Q_{n+1}$ |
|---|---|-----------|
| L | L | $Q_n$     |
| L | H | H         |
| H | L | L         |
| H | H | N.D.      |

N.D. = Not Defined

CLOCKED TRUTH TABLE

| C | D      | $Q_{n+1}$ |
|---|--------|-----------|
| L | $\phi$ | $Q_n$     |
| H | L      | L         |
| H | H      | H         |

$\phi$  = Don't Care

$C = \overline{C_E} + C_C$

A clock H is a clock transition from a low to a high state.

(53) MB10135C (MC10135)

DUAL J-K MASTER-SLAVE FLIP-FLOPS

The MC10135 is a dual master-slave dc coupled J-K flip-flop. Asynchronous set (S) and reset (R) are provided. The set and reset inputs override the clock.

A common clock is provided with separate  $\bar{J}$   $\bar{K}$  inputs. When the clock is static, the  $\bar{J}$ - $\bar{K}$  inputs do not affect the output.

The output states of the flip-flop change on the positive transition of the clock.

Input pulldown resistors eliminate the need to tie unused inputs to  $V_{EE}$ . Output rise and fall times have been optimized to provide relaxation of system design and layout criteria.

R-S TRUTH TABLE

| R | S | $Q_{n+1}$ |
|---|---|-----------|
| L | H | H         |
| H | L | L         |
| H | H | N.D.      |

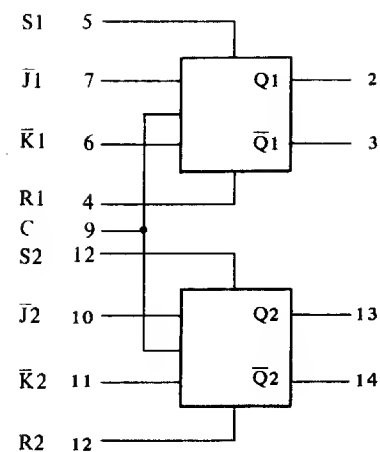
N.D. = Not Defined

CLOCK J-K TRUTH TABLE

| J | K | $Q_{n+1}$   |
|---|---|-------------|
| H | L | $Q_n$       |
| L | H | H           |
| H | H | $\bar{Q}_n$ |

Output states change on positive transition of clock for J-K input condition present.

POSITIVE LOGIC

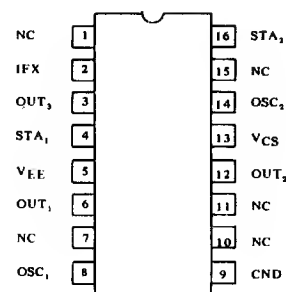
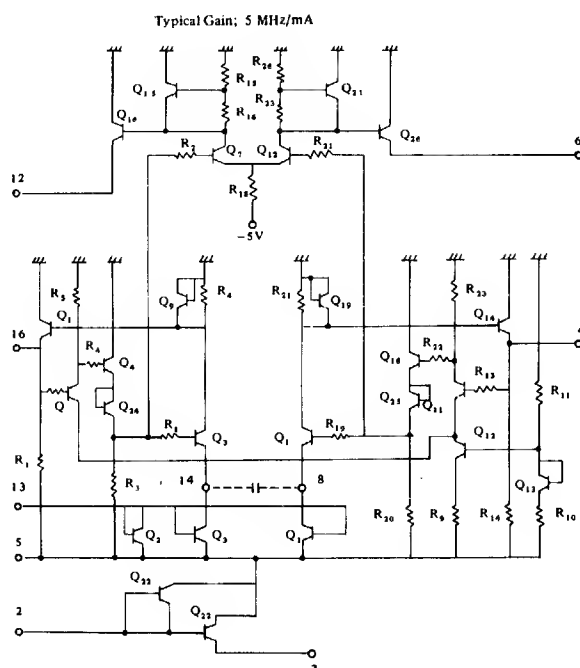


$V_{CC1}$  = Pin 1  
 $V_{CC2}$  = Pin 16  
 $V_{EE}$  = Pin 8

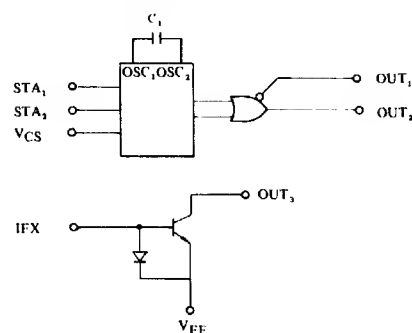
(54) HD103107

VOLTAGE CONTROLLED OSCILLATOR

Typical Gain; 5 MHz/mA



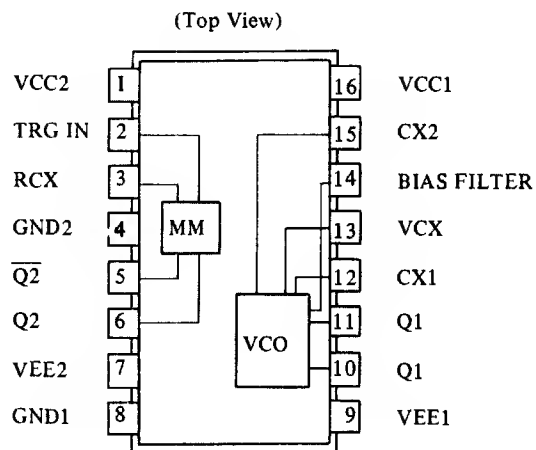
Functional block diagram



(55) MB4306C

#### VOLTAGE CONTROLLED OSCILLATOR

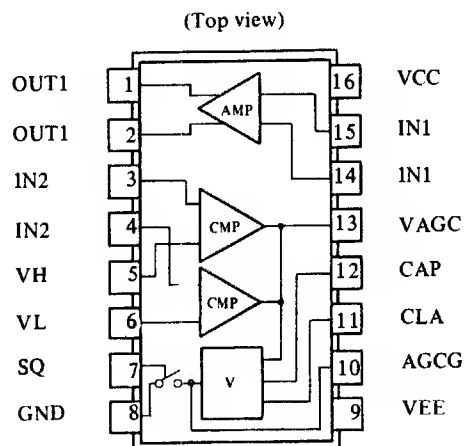
The MB4306C is mainly used as an oscillator with its oscillating frequency synchronous with the rotational speed of the disks. The output clock signal is used to modulate and demodulate the write and read data. The circuit consists of two portions, one is oscillator whose output frequency varies with the input control voltage level, and the other is a monostable multi-vibrator which is generally used in demodulating the read data.



(56) MB4311C

#### LEVEL SENSOR

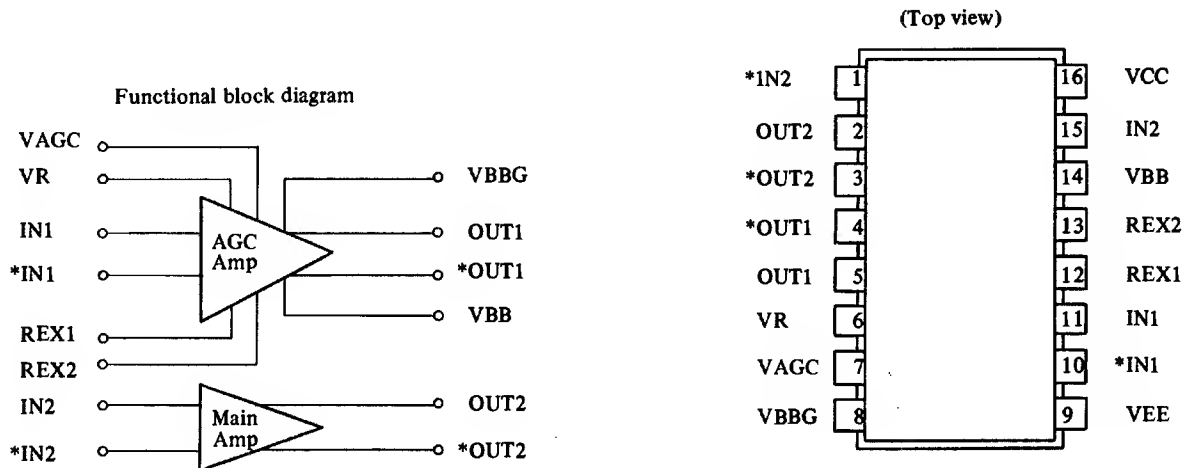
The MB4311C is used in conjunction with the MB4303C (AGC Amplifier) to keep the read out signal derived from a magnetic head at a constant level. It also contains an amplifier with a gain of 10.



(57) MB4303C

### AGC AMPLIFIER

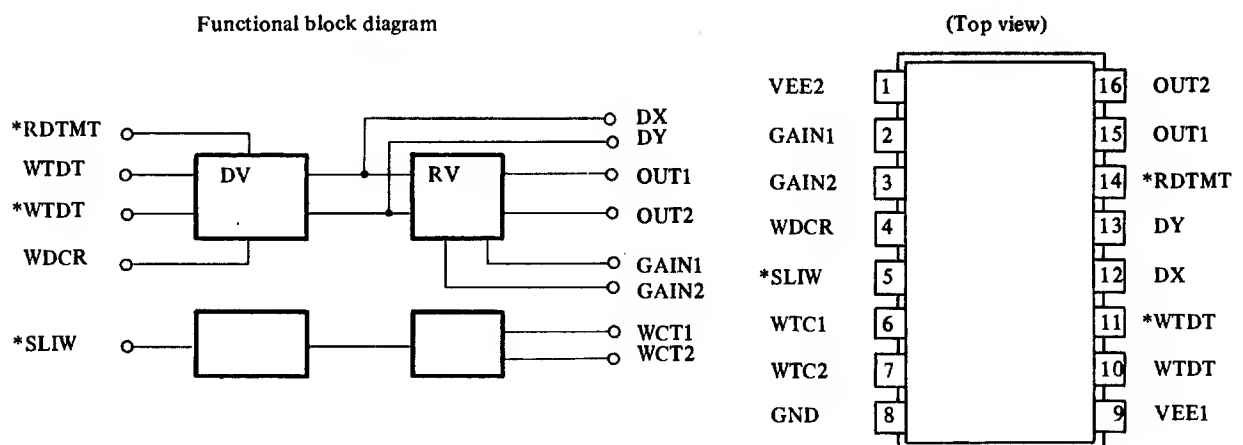
The MB4303C is used in conjunction with the MB4311C (Level Sensor) to keep the read out signal derived from a magnetic head at a constant level. It also contains an amplifier.



(58) MB4316C

### READ/WRITE BUS SWITCH C

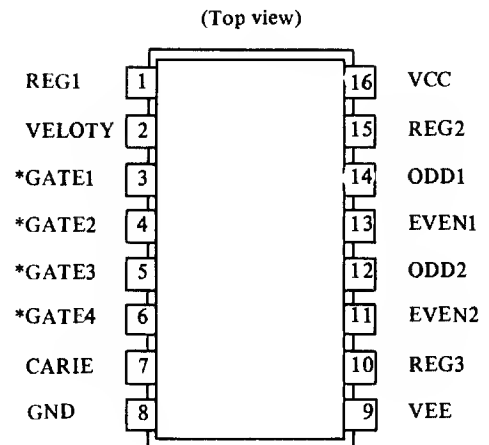
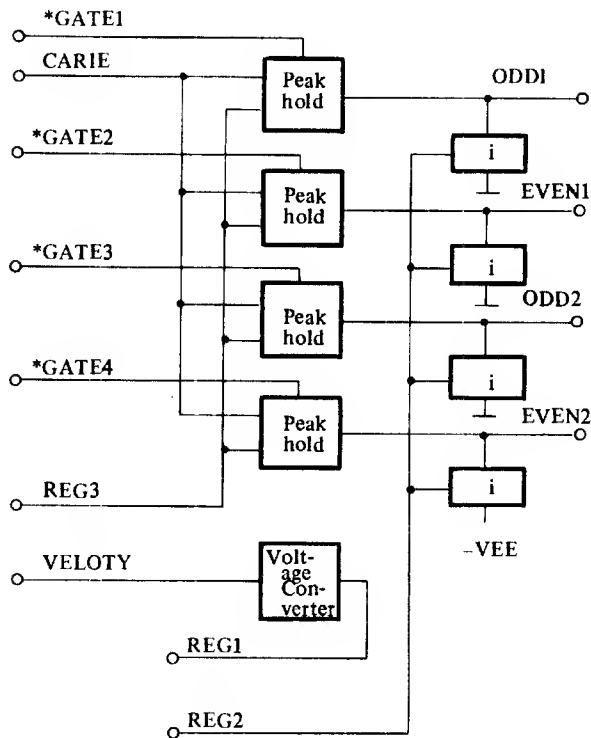
The MB4316C contains a driver and a receiver circuit to transmit write/read data to/from the Head IC. It also generates the write-current which flows in a magnetic head during a write operation.



(59) MB4319C

PEAK HOLD

The MB4319C is used in the position sensing circuit of the disk drive. The peak-voltage of raw-servo signal is hold for demodulating inot the position signal.



(60) MB4112 (SS1105)  
MB4113

DISK HEAD IC (FIXED/MOVABLE)

The MB4112 and MB4113 are analog LSIs for Fixed-Head and Movable-Head respectively used in the disk drive. The MB4112 has lower amplifier gain depending on characteristics of magnetic head. Both can control up to four heads and contain the following circuits.

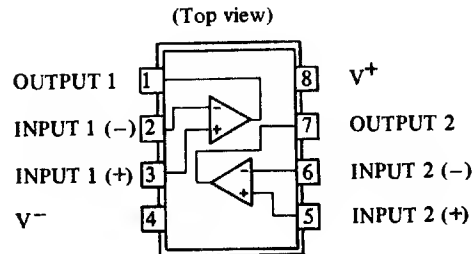
- Read amplifier
- Write amplifier
- RAS circuit
- Head select circuit



(62) MB3607M ( $\mu$ pC251C, MC1458C)

#### DUAL OPERATIONAL AMPLIFIERS

The MB3607M is designed for use as a summing amplifier integrator, or amplifier with operating characteristics as a function of the external feed-back components.



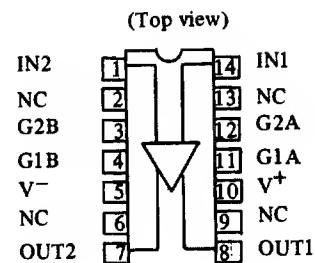
(63) MB3501M ( $\mu$ A733DM)

#### DIFFERENTIAL VIDEO AMPLIFIER

The MB3501M is a monolithic tow-stage Differential Input and Output Video Amplifier.

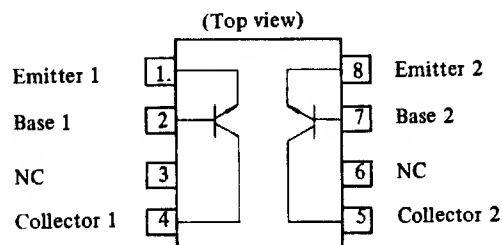
Internal series-shunt feedback is used to obtain wide bandwidth, low phase distortion, and excellent gain stability. Emitter follower outputs enable the device to drive capacitive loads and all stages are current-source biased to obtain high power supply and common mode rejection ratios. It offers fixed gains of 10, 100 or 400 without external components,

and adjustable gains from 10 to 400 by the use of a single external resistor. No external frequency compensation components are required for any gain option. The device is particularly useful in magnetic tape or disc file systems using phase or NRZ encoding and in high speed film or plate wire memories. Other applications include general purpose video and pulse amplifiers where wide bandwidth, low phase shift, and excellent gain stability are required.



(64) MB5365M

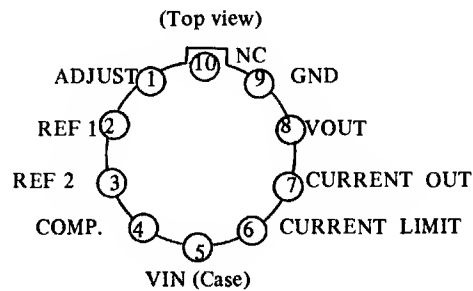
#### NPN DUAL TRANSISTORS



(65)  $\mu$ PC142A

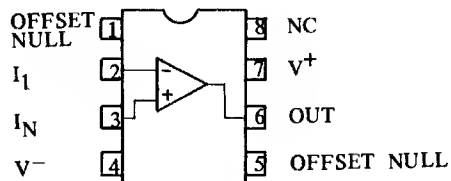
NEGATIVE VOLTAGE REGULATOR

The  $\mu$ PC142A is a precision negative voltage regulator, consisting of temperature-compensated reference constant current source and a differential error amplifier with emitter follower input. The output voltage is adjustable from  $-0.035\text{V}$  to  $030\text{V}$ . In addition, an external pass transistor enhances output current capability up to  $10\text{A}$ . The current limiting circuit is incorporated and the limiting current is externally adjustable. The applications include negative voltage supply for operational amplifiers.



(66)  $\mu$ PC151C

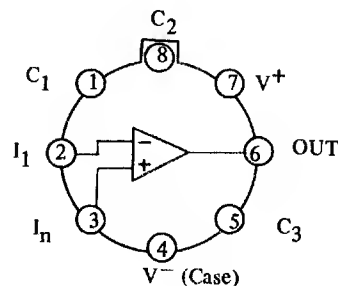
FREQUENCY COMPENSATED OPERATIONAL AMPLIFIER



(67)  $\mu$ PC159A

HIGH SPEED WIDE BAND OPERATIONAL AMPLIFIER

(top view)

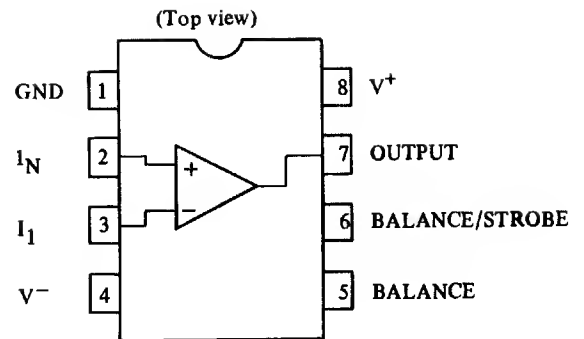




(68)  $\mu$ PC271C

VOLTAGE COMPARATOR

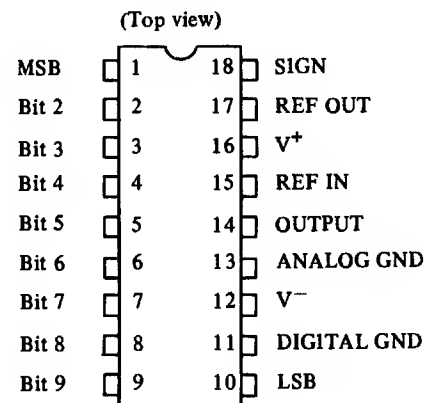
This is a single high-speed voltage comparator. This device is designed to operate from a wide range of power supply voltage, including  $\pm 15V$  supplies for operational amplifiers and  $+5$  supplies for logic systems. The output level is compatible with most DTL, TTL, and MOS circuits. This comparator is capable of driving Lamps or relays and switching voltage up to  $50V$  at  $50mA$ . All inputs and outputs can be isolated from system ground. The output can drive loads referenced to ground,  $V_{cc+}$ ,  $V_{cc-}$ . Offset balancing and strobe capability are available and the output can be wire-OR connected. If the strobe input is low, the output will be in the off state regardless of the differential input.



(69)  $\mu$ PC610D

10-BIT D/A CONVERTER

The  $\mu$ PC610D is a complete 10 bit plus sign D/A convertor. All elements of a complete sign/magnitude DAC are included-precision voltage reference, current steering logic, current sources, R-2R resistor network, logic controlled polarity switch and high speed internally compensated output of amp. The wide power supply range, low power consumption, choice of full scale output voltages and sign/magnitude coding assure utility in a wide range of applications.



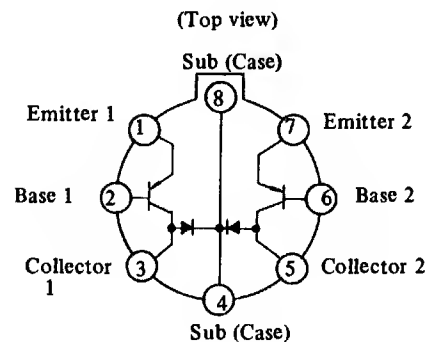
(70)  $\mu$ PA49A

PNP DUAL TRANSISTORS

$$I_C = -50 \text{ mA}$$

$$f_T = 250 \text{ MHz}$$

$$P_c = 300 \text{ mW/UNIT}$$



QUAD ANALOG SWITCHES

(Top view)

IN 1

D1

S1

V<sup>-</sup>

GND

S4

D4

IN4

16

15

14

13

12

11

10

9

IN2

D2

S2

V<sup>+</sup>

VRET

S3

D3

IN3

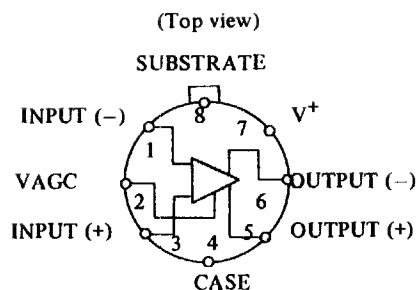
| LOGIC | SWITCH |
|-------|--------|
| 0     | ON     |
| 1     | OFF    |

## TIMING CIRCUIT

(Top view)

The top view shows a rectangular circuit board with 8 pins. The pins are numbered 1 through 8. Pins 1, 2, 3, and 4 are on the left side, and pins 8, 7, 6, and 5 are on the right side. The board is oriented horizontally.

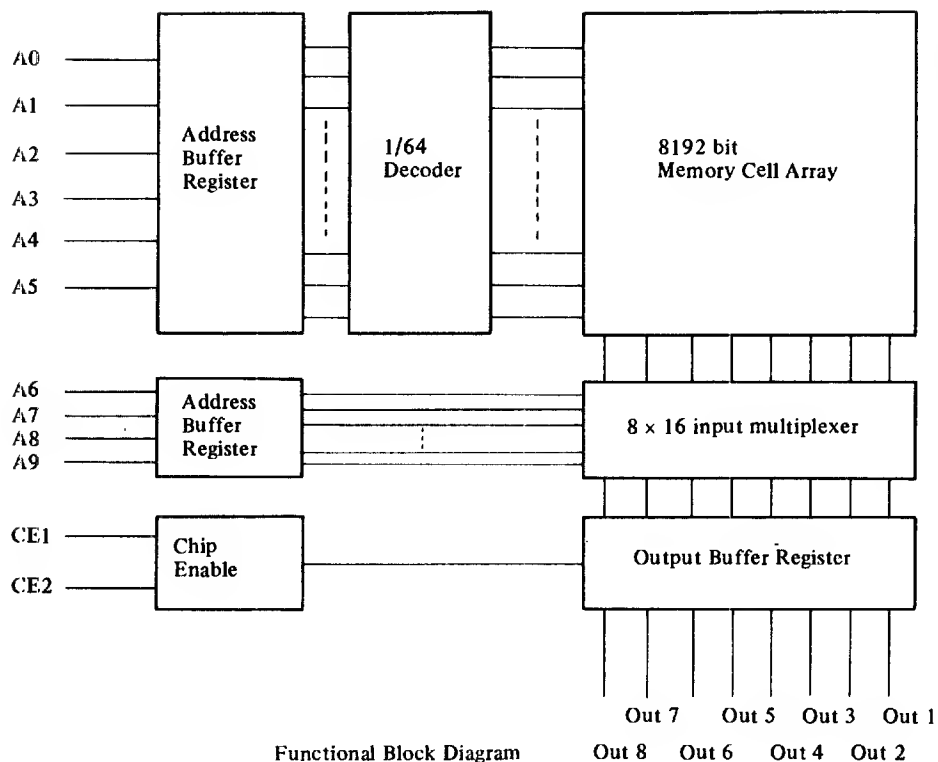
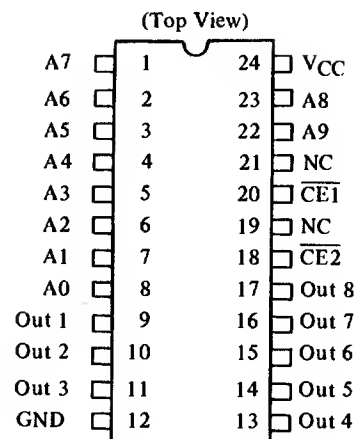
(73) MC1590G  
AGC AMPLIFIER



(74) MB7055C  
8192-BIT PROGRAMMABLE READ ONLY MEMORY

The MB7055C is a 1024 × 8 bit bipolar programmable read only memory

A0 ~ A9 ; Address input  
 Out1 ~ Out8; Data Output  
 CE1 CE2 ; Chip enable  
 Vcc ; +5V



Functional Block Diagram

CHAPTER 17 SCHEMATICS

17.1 SCHEMATICS/DRAWINGS

LOGIC

DQFMU

DQEMU

| SHEET | ABBR | T | I | T | I | E                                          |
|-------|------|---|---|---|---|--------------------------------------------|
| 0 0 1 |      |   |   |   |   | Schematics/Drawings List                   |
| 0 0 2 | AA1  |   |   |   |   | CHA Interface Circuit Diagram (1)          |
| 0 0 3 | AA2  |   |   |   |   | CHA Interface Circuit Diagram (2)          |
| 0 0 4 | AA3  |   |   |   |   | CHA Interface Circuit Diagram (3)          |
| 0 0 5 | AA4  |   |   |   |   | CHA Interface Circuit Diagram (4)          |
| 0 0 6 | AA5  |   |   |   |   | CHA Interface Circuit Diagram (5)          |
| 0 0 7 | AB1  |   |   |   |   | CHB Interface Circuit Diagram (1)          |
| 0 0 8 | AB2  |   |   |   |   | CHB Interface Circuit Diagram (2)          |
| 0 0 9 | AB3  |   |   |   |   | CHB Interface Circuit Diagram (3)          |
| 0 1 0 | AB4  |   |   |   |   | CHB Interface Circuit Diagram (4)          |
| 0 1 1 | AB5  |   |   |   |   | CHB Interface Circuit Diagram (5)          |
| 0 1 2 | AB6  |   |   |   |   | CHB Interface Circuit Diagram (6)          |
| 0 1 3 | AB7  |   |   |   |   | CHB Interface Circuit Diagram (7)          |
| 0 1 4 | BA1  |   |   |   |   | Interface Circuit Diagram (1)              |
| 0 1 5 | BA2  |   |   |   |   | Interface Circuit Diagram (2)              |
| 0 1 6 | BA3  |   |   |   |   | Interface Circuit Diagram (3)              |
| 0 1 7 | CA1  |   |   |   |   | Access Control Circuit Diagram (1)         |
| 0 1 8 | CA2  |   |   |   |   | Access Control Circuit Diagram (2)         |
| 0 1 9 | CA3  |   |   |   |   | Access Control Circuit Diagram (3)         |
| 0 2 0 | CA4  |   |   |   |   | Access Control Circuit Diagram (4)         |
| 0 2 1 | CA5  |   |   |   |   | Access Control Circuit Diagram (5)         |
| 0 2 2 | DA1  |   |   |   |   | Read Address Register Circuit Diagram      |
| 0 2 3 | EA1  |   |   |   |   | R/W Control Circuit Diagram (1)            |
| 0 2 4 | EA2  |   |   |   |   | R/W Control Circuit Diagram (2)            |
| 0 2 5 | FA1  |   |   |   |   | VFO Control Circuit Diagram (1)            |
| 0 2 6 | FA2  |   |   |   |   | VFO Control Circuit Diagram (2)            |
| 0 2 7 | FA3  |   |   |   |   | VFO Control Circuit Diagram (3)            |
| 0 2 8 | GA1  |   |   |   |   | Sector Control Circuit Diagram (1)         |
| 0 2 9 | GA2  |   |   |   |   | Sector Control Circuit Diagram (2)         |
| 0 3 0 | HA1  |   |   |   |   | Servo Pattern Detector Circuit Diagram (1) |

LOGIC...  
CABLE  
PS  
RFJAU

| SHEET | ABBR | T | I | T | I | E                                          |
|-------|------|---|---|---|---|--------------------------------------------|
| 0 3 1 | HA2  |   |   |   |   | Servo Pattern Detector Circuit Diagram (2) |
| 0 3 2 | HA3  |   |   |   |   | Servo Pattern Detector Circuit Diagram (3) |
| 0 3 3 | JA1  |   |   |   |   | DE Sequencer Circuit Diagram (1)           |
| 0 3 4 | JA2  |   |   |   |   | DE Sequencer Circuit Diagram (2)           |
| 0 3 5 | JA3  |   |   |   |   | DE Sequencer Circuit Diagram (3)           |
| 0 3 6 | KA1  |   |   |   |   | Servo Circuit Diagram                      |
| 0 3 7 | LA1  |   |   |   |   | Read Amplifier Circuit Diagram             |
| 0 3 8 | MA1  |   |   |   |   | Internal Connection Circuit Diagram (1)    |
| 0 3 9 | MA2  |   |   |   |   | Internal Connection Circuit Diagram (2)    |
| 0 4 0 | MA3  |   |   |   |   | Internal Connection Circuit Diagram (3)    |
| 0 4 1 | MA4  |   |   |   |   | Internal Connection Circuit Diagram (4)    |
| 0 4 2 | MA5  |   |   |   |   | Internal Connection Circuit Diagram (5)    |
| 0 4 3 | MA6  |   |   |   |   | Internal Connection Circuit Diagram (6)    |
| 0 4 4 | MA7  |   |   |   |   | Internal Connection Circuit Diagram (7)    |
| 0 4 5 | MA8  |   |   |   |   | Internal Connection Circuit Diagram (8)    |
| 0 4 6 | MB1  |   |   |   |   | Internal Cable Connection Diagram (1)      |
| 0 4 7 | MB2  |   |   |   |   | Internal Cable Connection Diagram (2)      |
| 0 4 8 | PA1  |   |   |   |   | Power Unit Circuit Diagram (1)             |
| 0 4 9 | PA2  |   |   |   |   | Power Unit Circuit Diagram (2)             |
| 0 5 0 | RA1  |   |   |   |   | Read Amplifier Circuit Diagram (1)         |
| 0 5 1 | RA2  |   |   |   |   | Read Amplifier Circuit Diagram (2)         |
| 0 5 2 | RA3  |   |   |   |   | Read Amplifier Circuit Diagram (3)         |
| 0 5 3 | RA4  |   |   |   |   | Read Amplifier Circuit Diagram (4)         |
| 0 5 4 | RA5  |   |   |   |   | Read Amplifier Circuit Diagram (5)         |
| 0 5 5 | RB1  |   |   |   |   | Variable Freq. Osc. Circuit Diagram (1)    |
| 0 5 6 | RB2  |   |   |   |   | Variable Freq. Osc. Circuit Diagram (2)    |
| 0 5 7 | RB3  |   |   |   |   | Variable Freq. Osc. Circuit Diagram (3)    |
| 0 5 8 | RB4  |   |   |   |   | Variable Freq. Osc. Circuit Diagram (4)    |
| 0 5 9 | RB5  |   |   |   |   | Variable Freq. Osc. Circuit Diagram (5)    |
| 0 6 0 | RB6  |   |   |   |   | Variable Freq. Osc. Circuit Diagram (6)    |

SVIAU  
PA

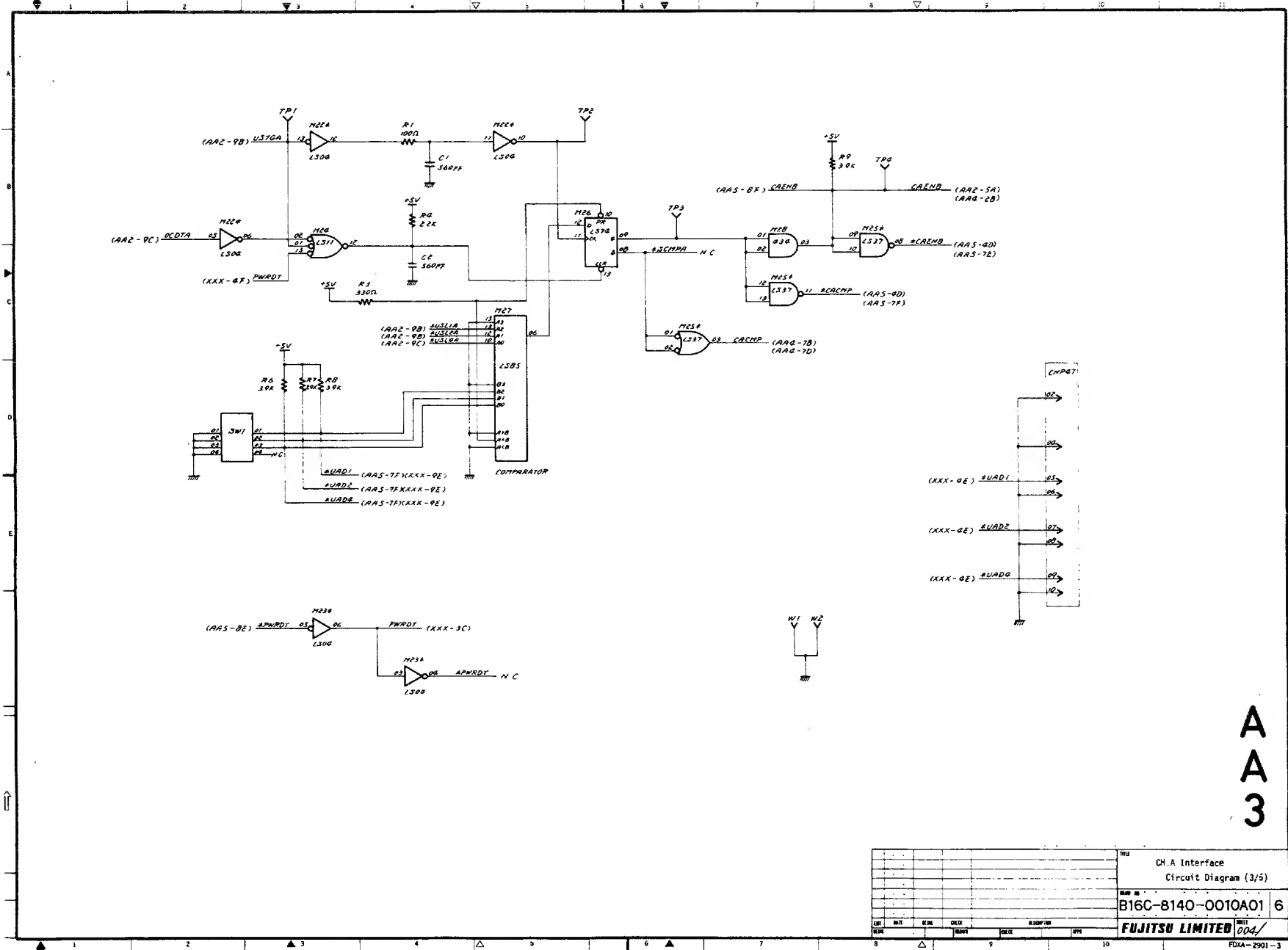
| SHEET | ABBR | T | I | T | I | E                                       |
|-------|------|---|---|---|---|-----------------------------------------|
| 0 6 1 | SA1  |   |   |   |   | Position Sensing Circuit Diagram (1)    |
| 0 6 2 | SA2  |   |   |   |   | Position Sensing Circuit Diagram (2)    |
| 0 6 3 | SA3  |   |   |   |   | Position Sensing Circuit Diagram (3)    |
| 0 6 4 | SB1  |   |   |   |   | Servo Control Circuit Diagram (1)       |
| 0 6 5 | SB2  |   |   |   |   | Servo Control Circuit Diagram (2)       |
| 0 6 6 | SB3  |   |   |   |   | Servo Control Circuit Diagram (3)       |
| 0 6 7 | SB4  |   |   |   |   | Servo Control Circuit Diagram (4)       |
| 0 6 8 | SB5  |   |   |   |   | Servo Control Circuit Diagram (5)       |
| 0 6 9 | SB6  |   |   |   |   | Servo Control Circuit Diagram (6)       |
| 0 7 0 | SB7  |   |   |   |   | Servo Control Circuit Diagram (7)       |
| 0 7 1 | TA1  |   |   |   |   | Power Amplifier Circuit Diagram (1)     |
| 0 7 2 | TA2  |   |   |   |   | Power Amplifier Circuit Diagram (2)     |
| 0 7 3 | TA3  |   |   |   |   | Power Amplifier Circuit Diagram (3)     |
| 0 7 4 | TA4  |   |   |   |   | Power Amplifier Circuit Diagram (4)     |
| 0 7 5 | UA1  |   |   |   |   | Indicator Circuit Diagram               |
| 0 7 6 | VA1  |   |   |   |   | Operator Panel Circuit Diagram          |
| 0 7 7 | -    |   |   |   |   | Logic Circuit 512388 Mounting Diagram   |
| 0 7 8 | -    |   |   |   |   | Read Amplifier RFJAU Mounting Diagram   |
| 0 7 9 | -    |   |   |   |   | Servo Circuit SVIAU Mounting Diagram    |
| 0 8 0 | -    |   |   |   |   | Indicator Circuit HCAU Mounting Diagram |
| 0 8 1 | -    |   |   |   |   | Indicator Circuit HCAU Mounting Diagram |
| 0 8 2 | -    |   |   |   |   | Power Amplifier TYMU Mounting Diagram   |
| 0 8 3 | -    |   |   |   |   | Driver Receiver DQFMU Mounting Diagram  |
| 0 8 4 | -    |   |   |   |   | Driver Receiver DQFMU Mounting Diagram  |

|                                                                                                                                                                                                                                                             |  |  |  |  |  |  |  |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|
| Schematic/Drawings List                                                                                                                                                                                                                                     |  |  |  |  |  |  |  |  |  |
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| FUJITSU LIMITED 201/                                                                                                                                                                                                                                        |  |  |  |  |  |  |  |  |  |





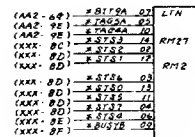
FDXA 2901 3



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A  
3

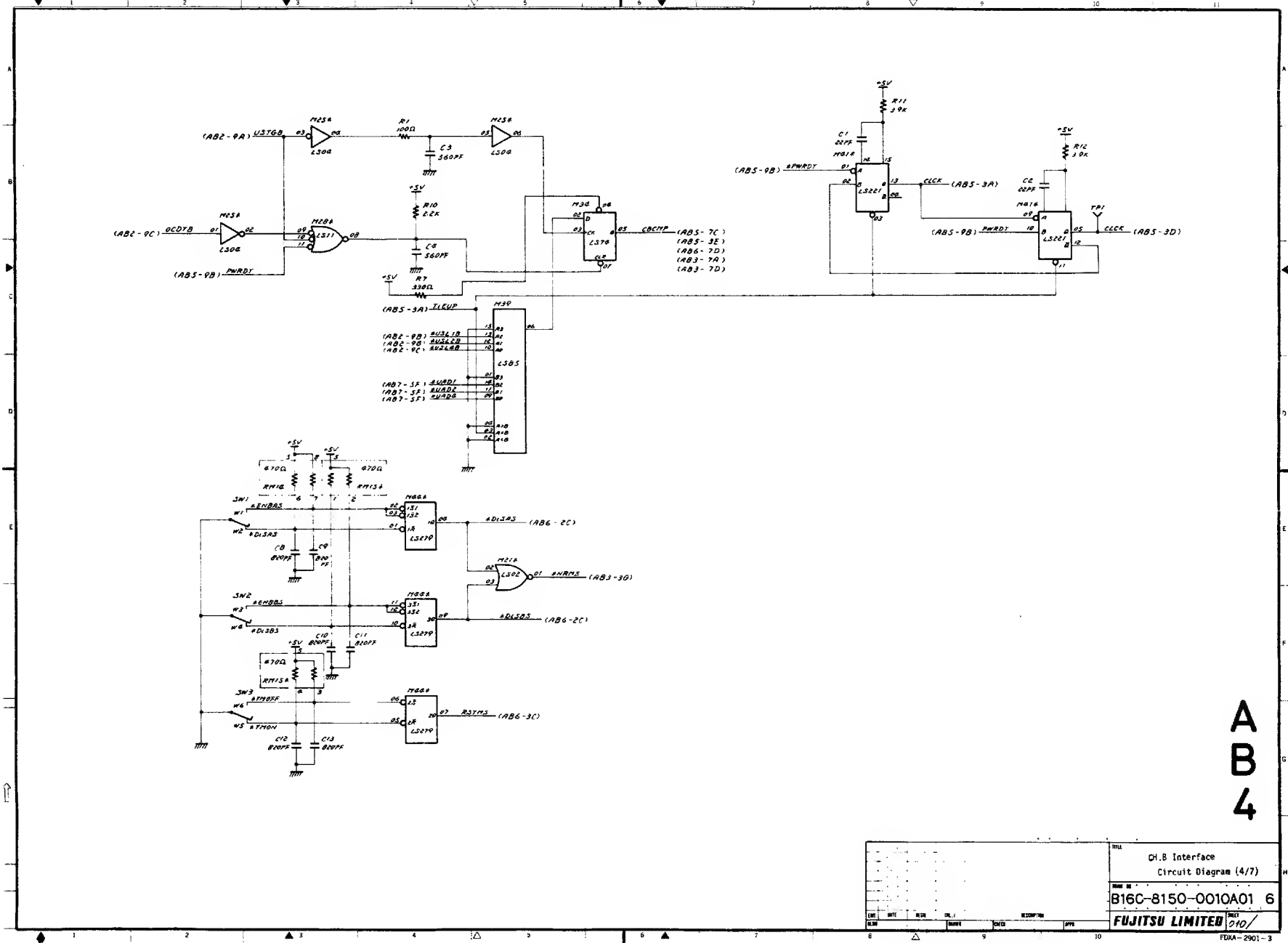




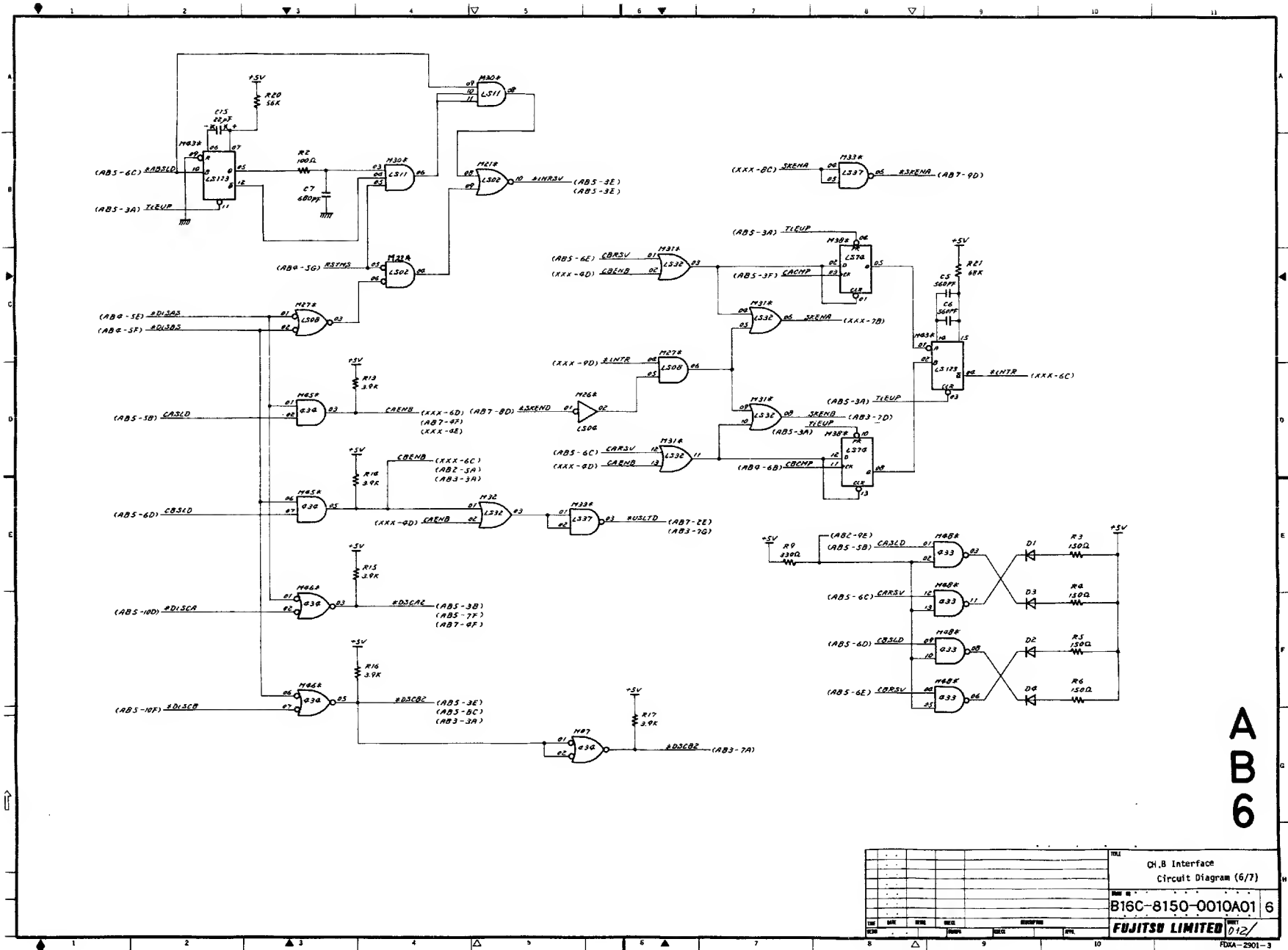






A  
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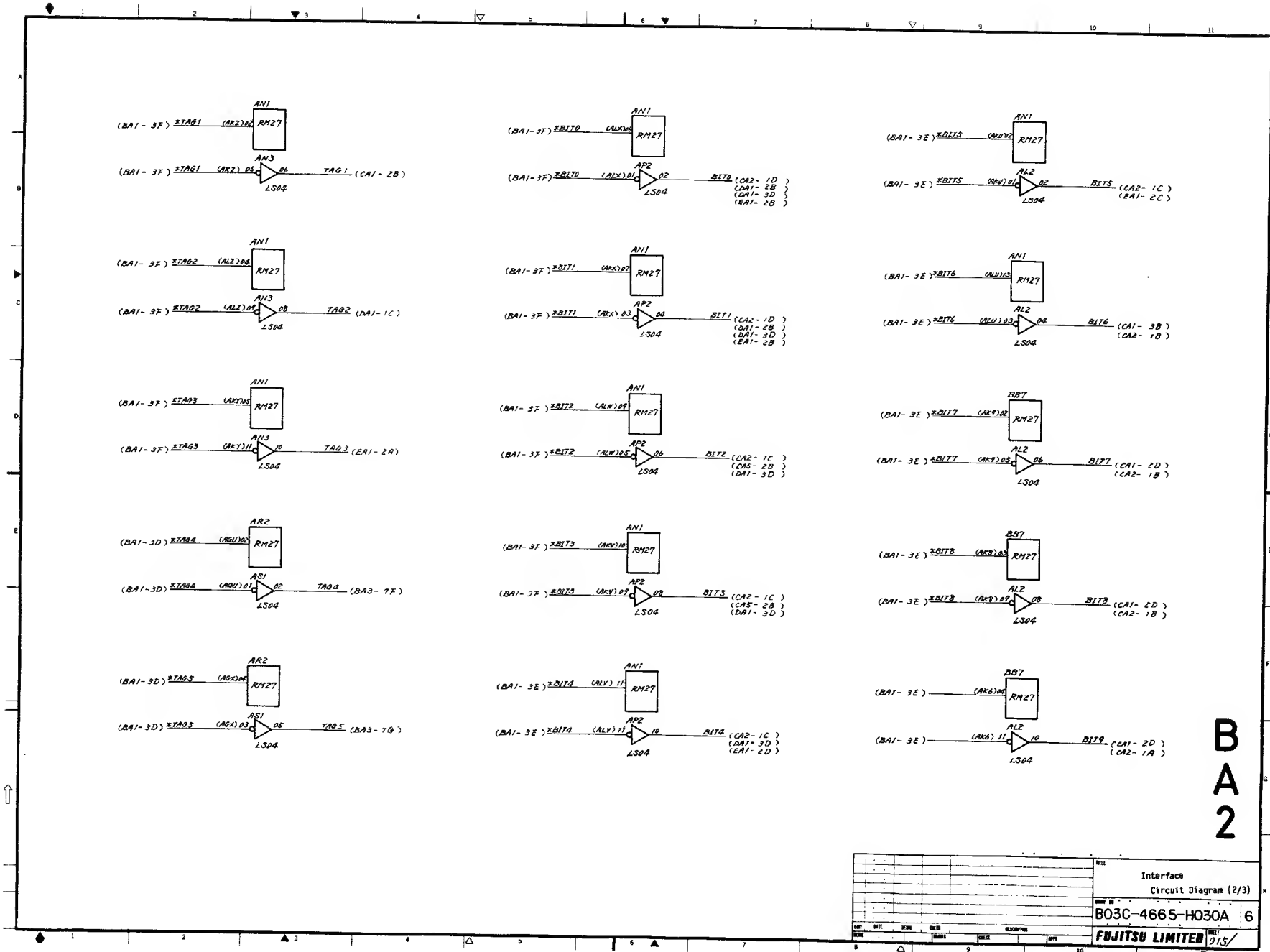


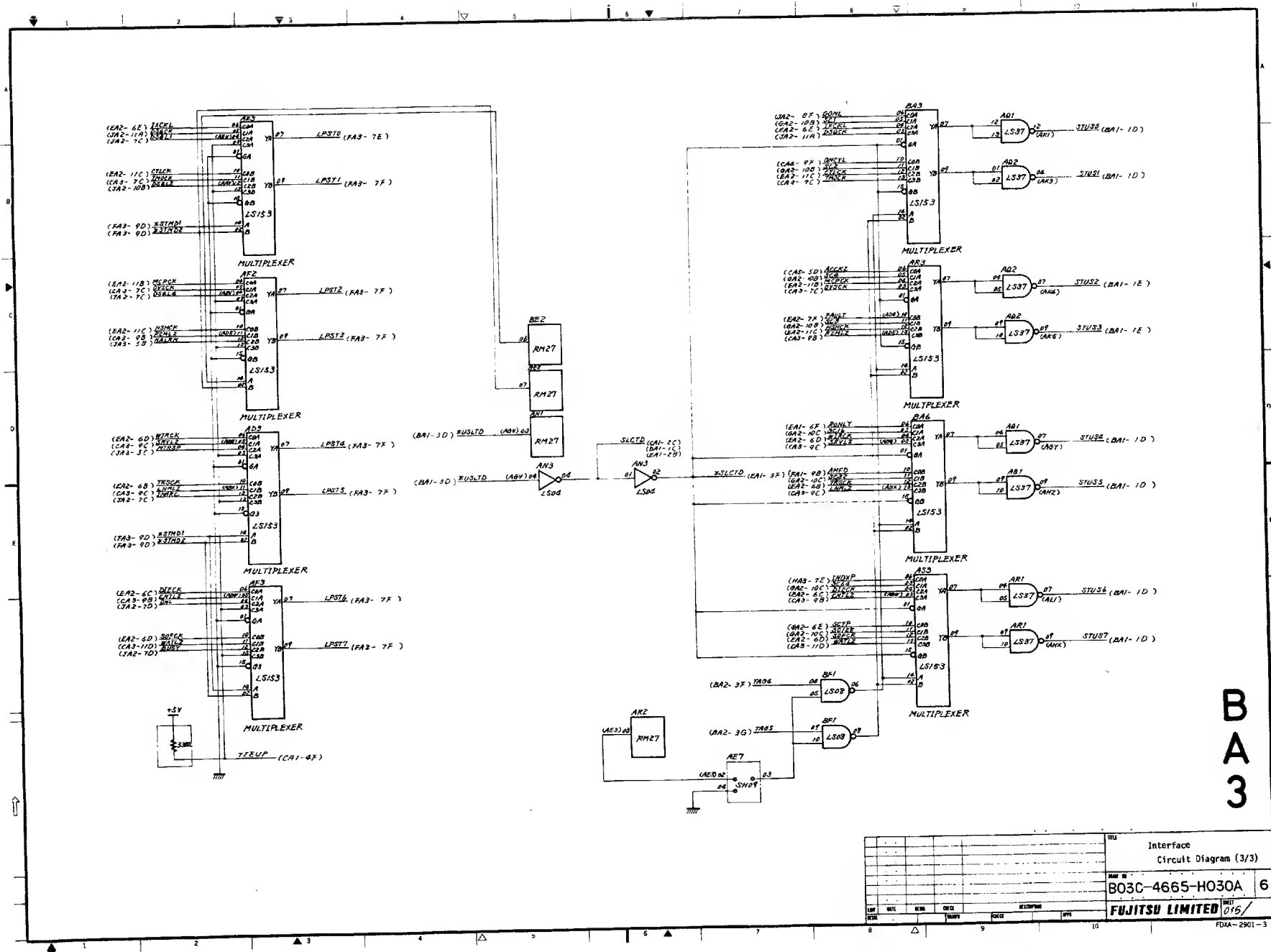


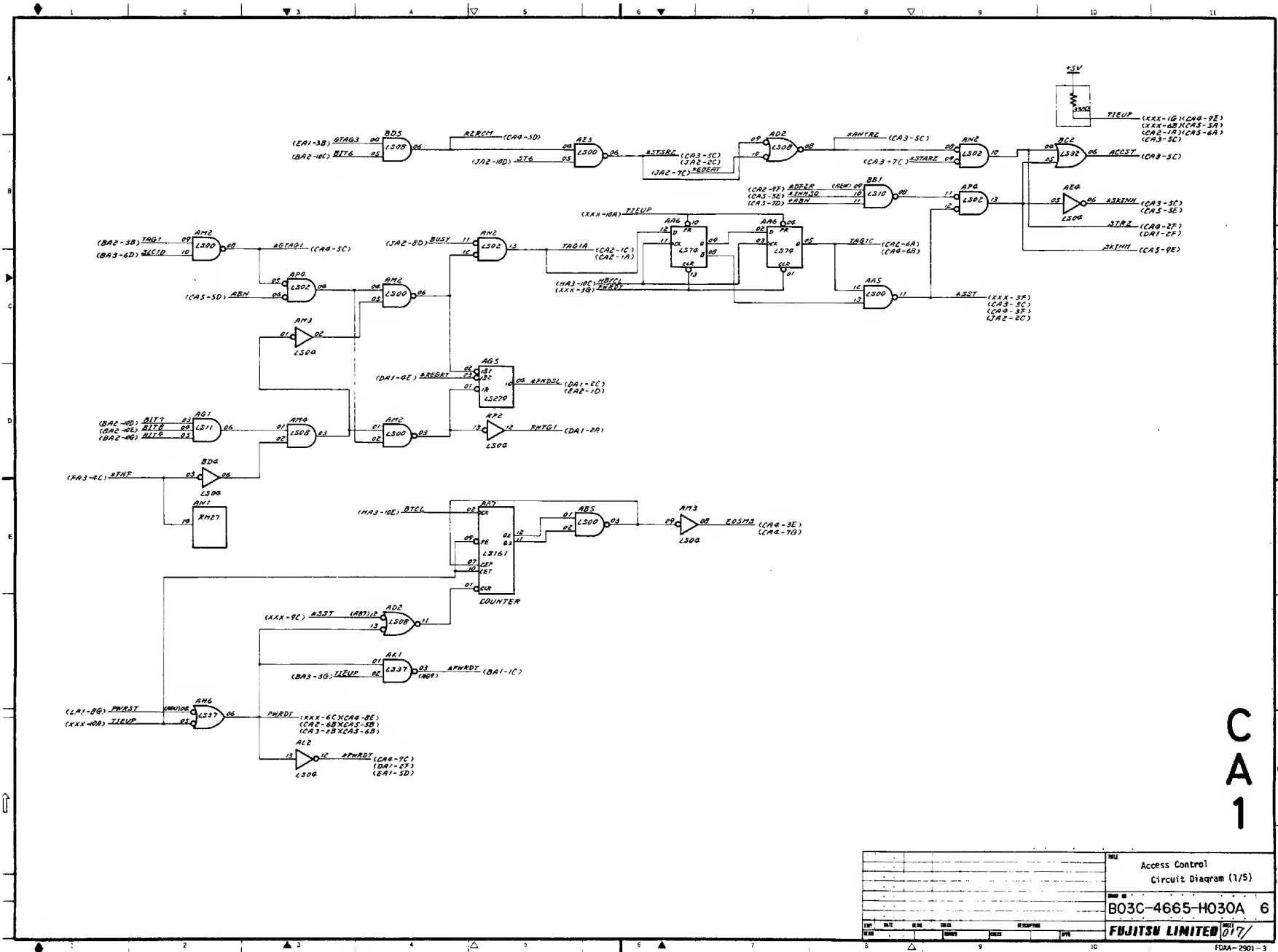








B  
A  
3



CA1

Access Control  
Circuit Diagram (1/5)

B03C-4665-H030A 6

FUJITSU LIMITED 017/

FOXA-2901-3







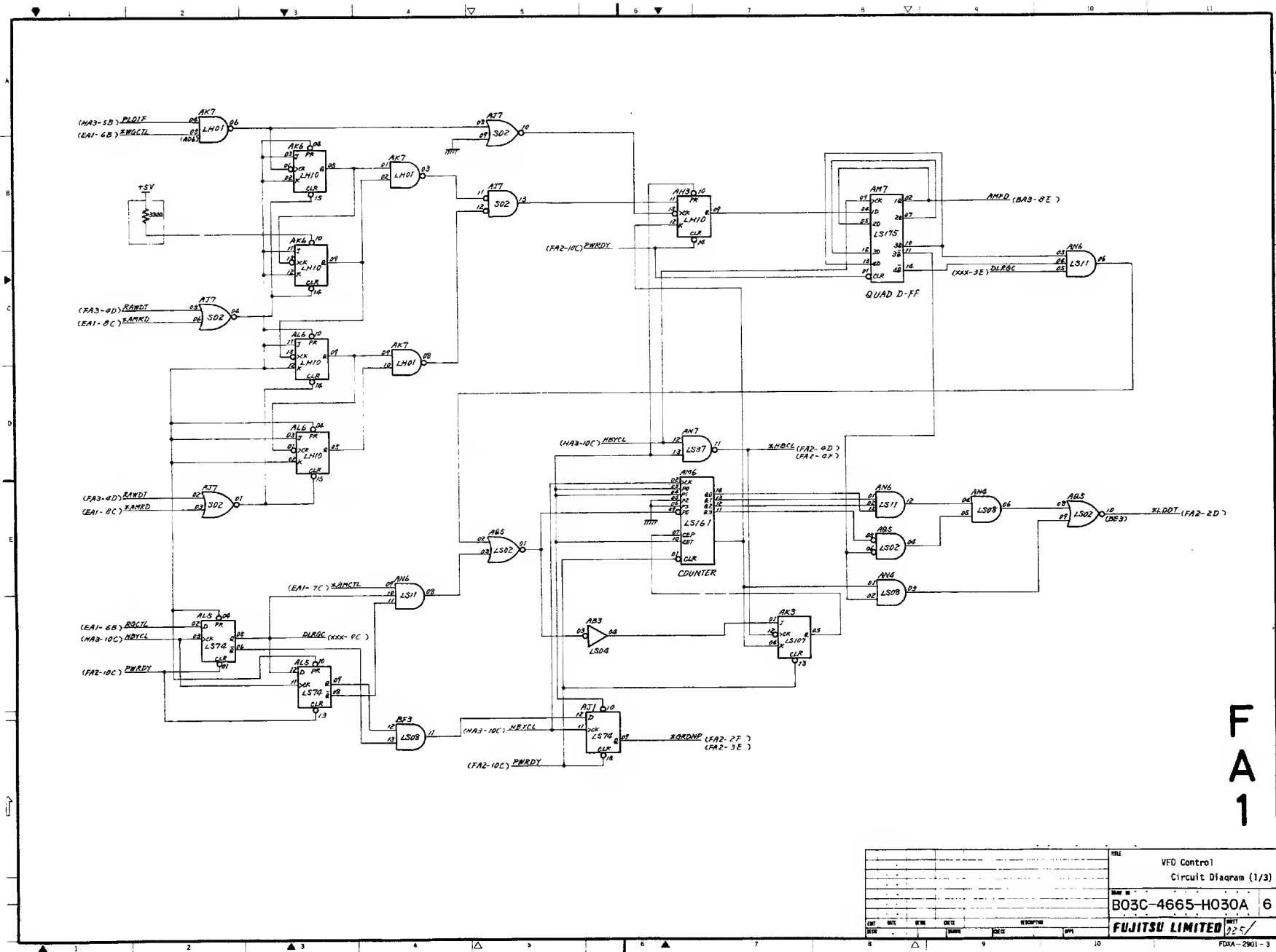


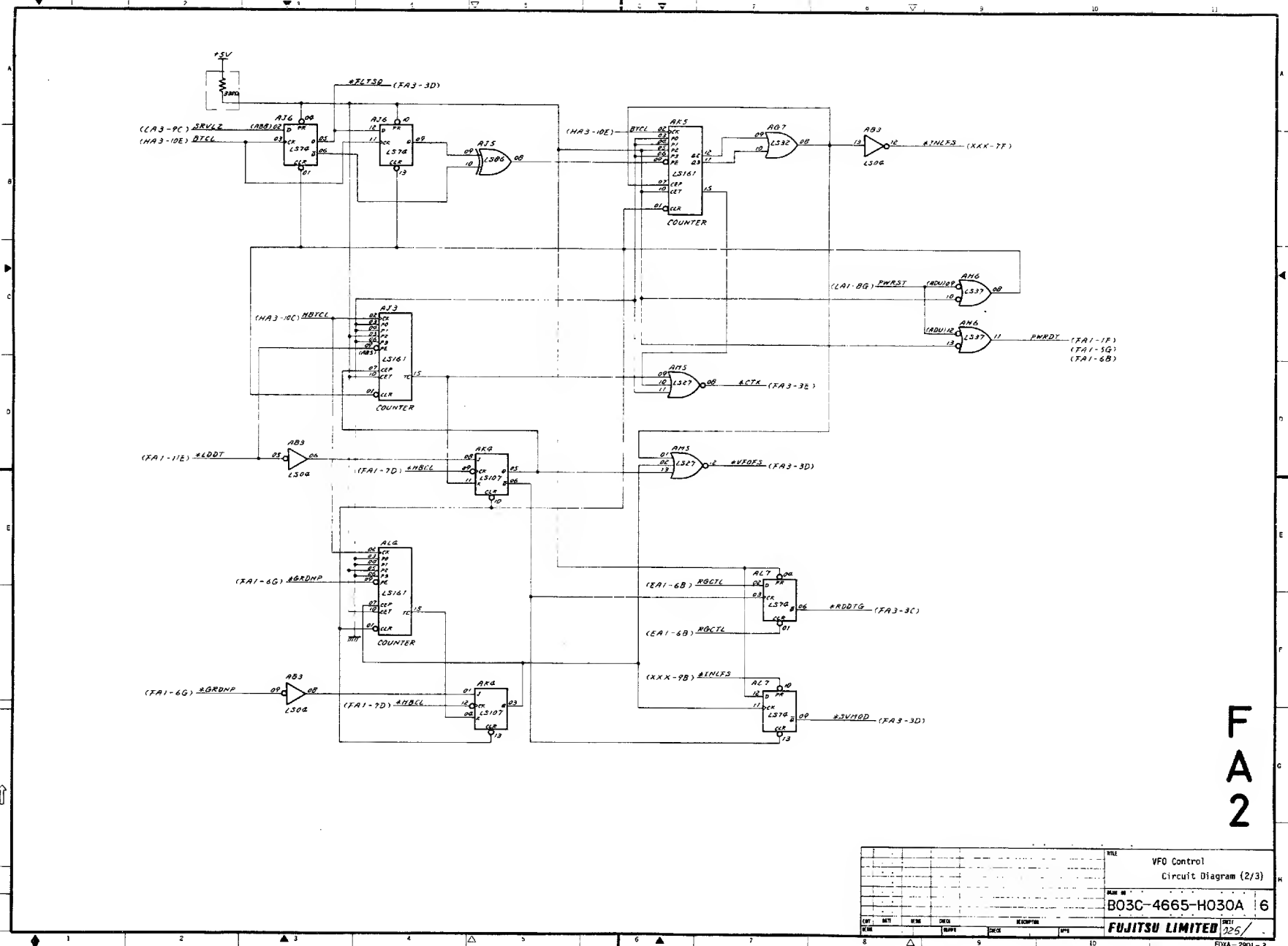




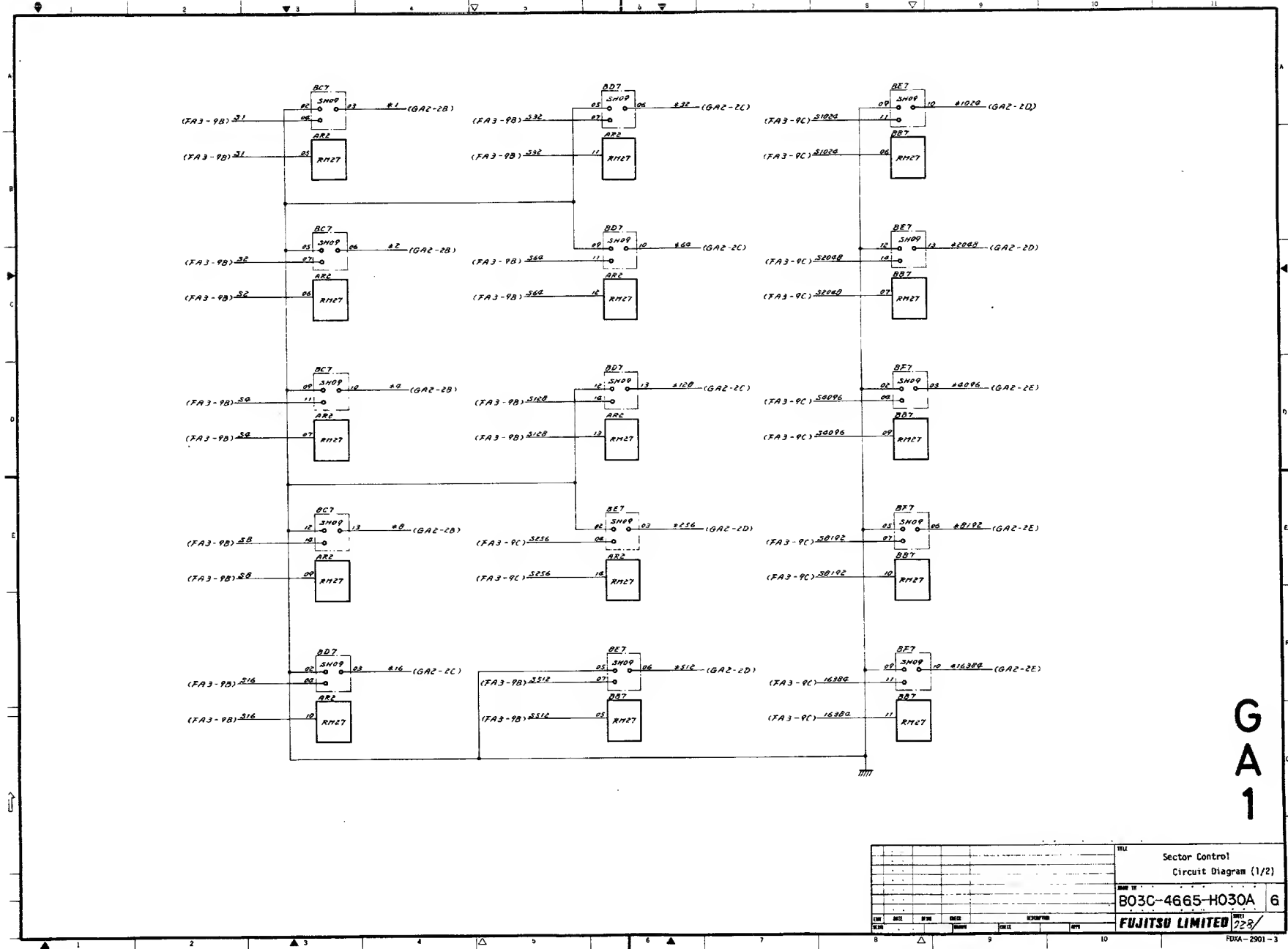






















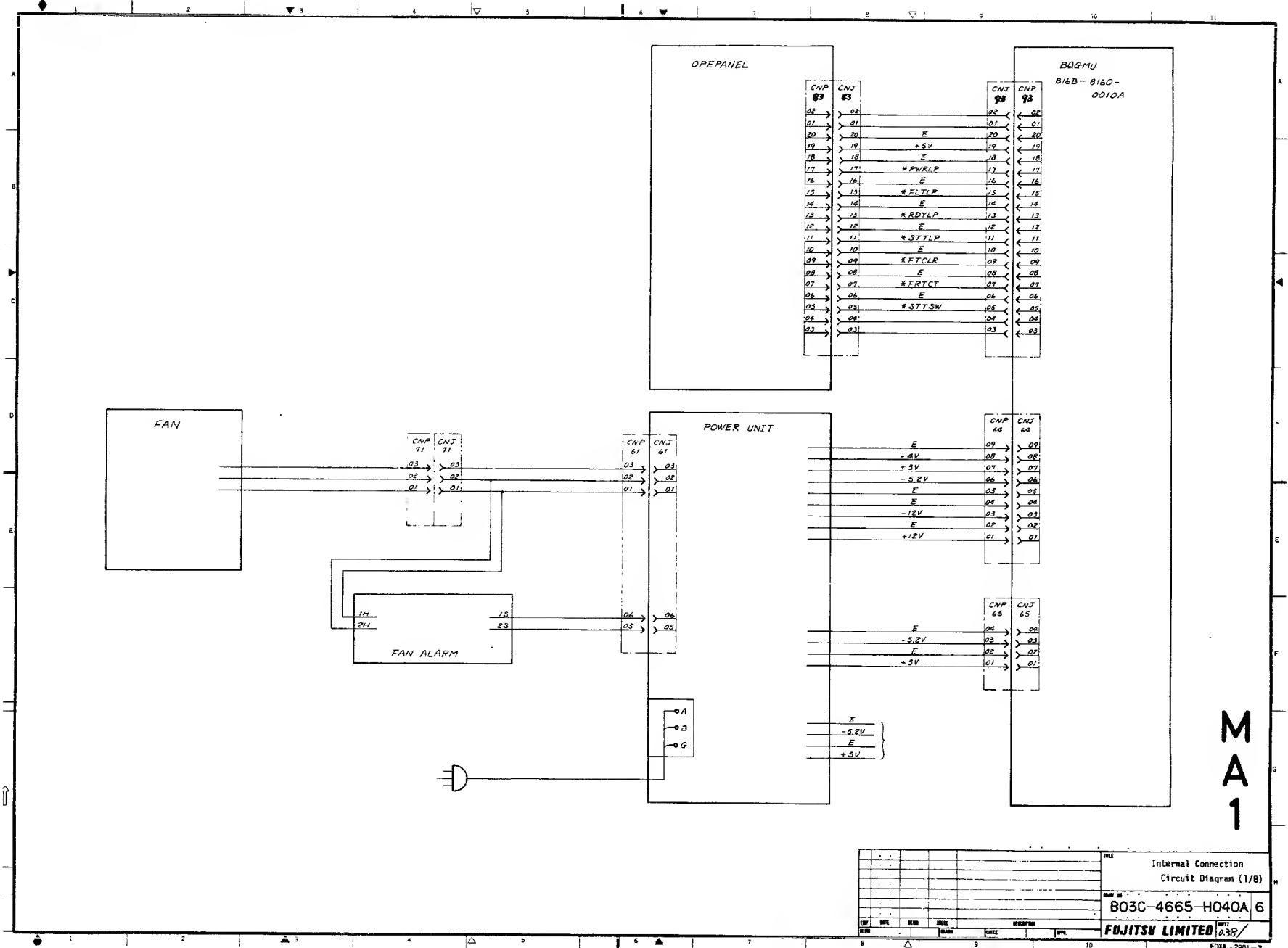










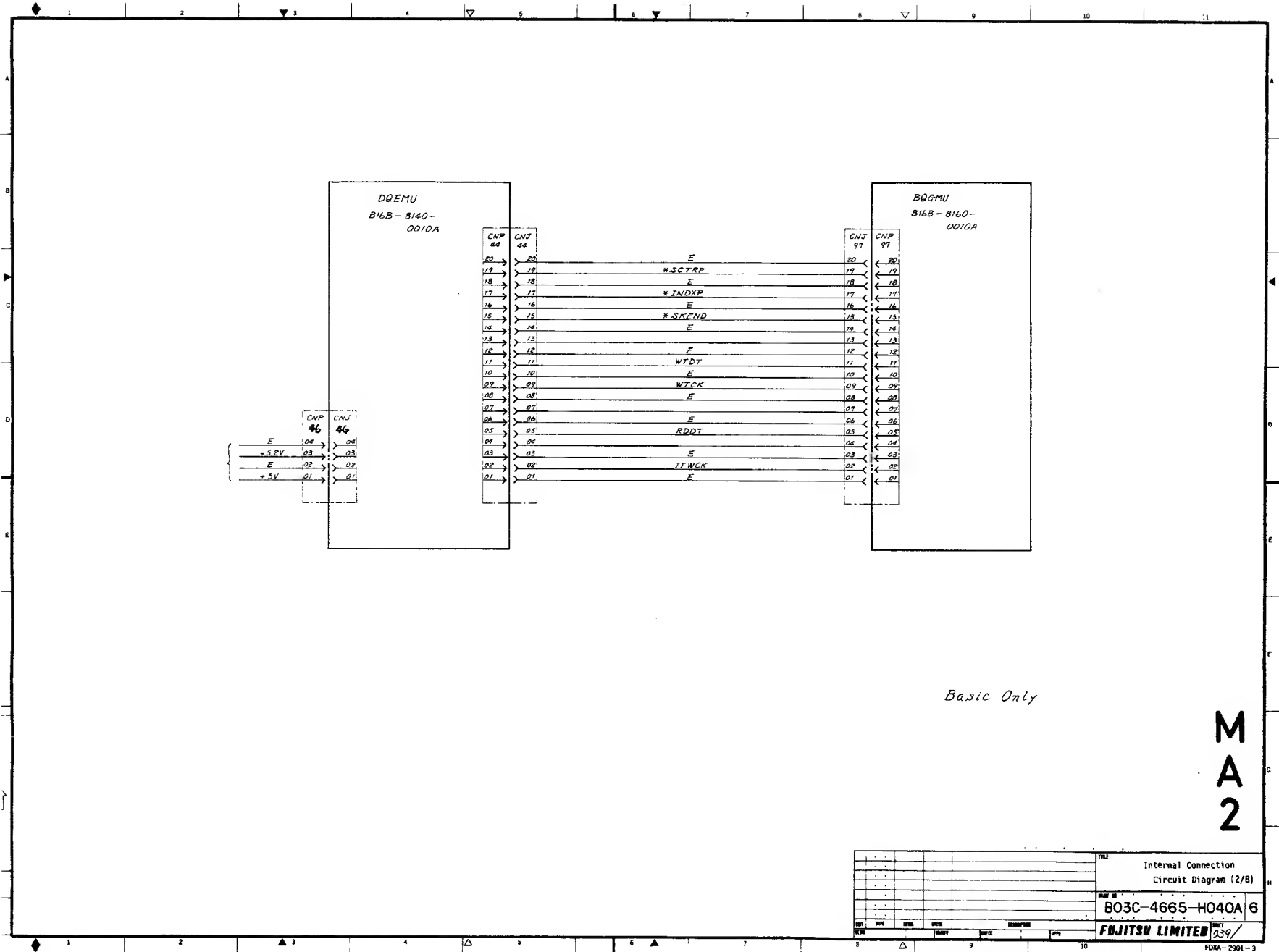


Internal Connection  
Circuit Diagram (1/8)

B03C-4665-H040A 6

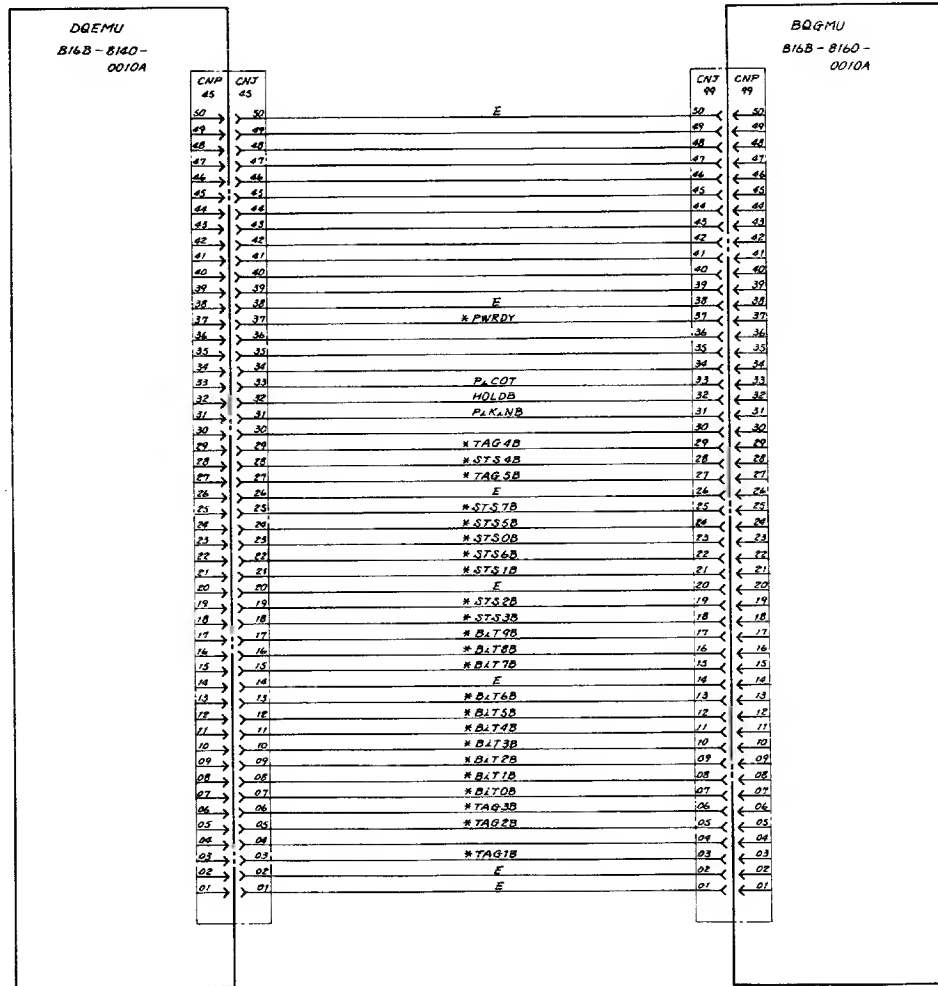
FUJITSU LIMITED





M  
A  
2

|  |  |  |  |                                              |  |  |  |
|--|--|--|--|----------------------------------------------|--|--|--|
|  |  |  |  | Internal Connection<br>Circuit Diagram (2/B) |  |  |  |
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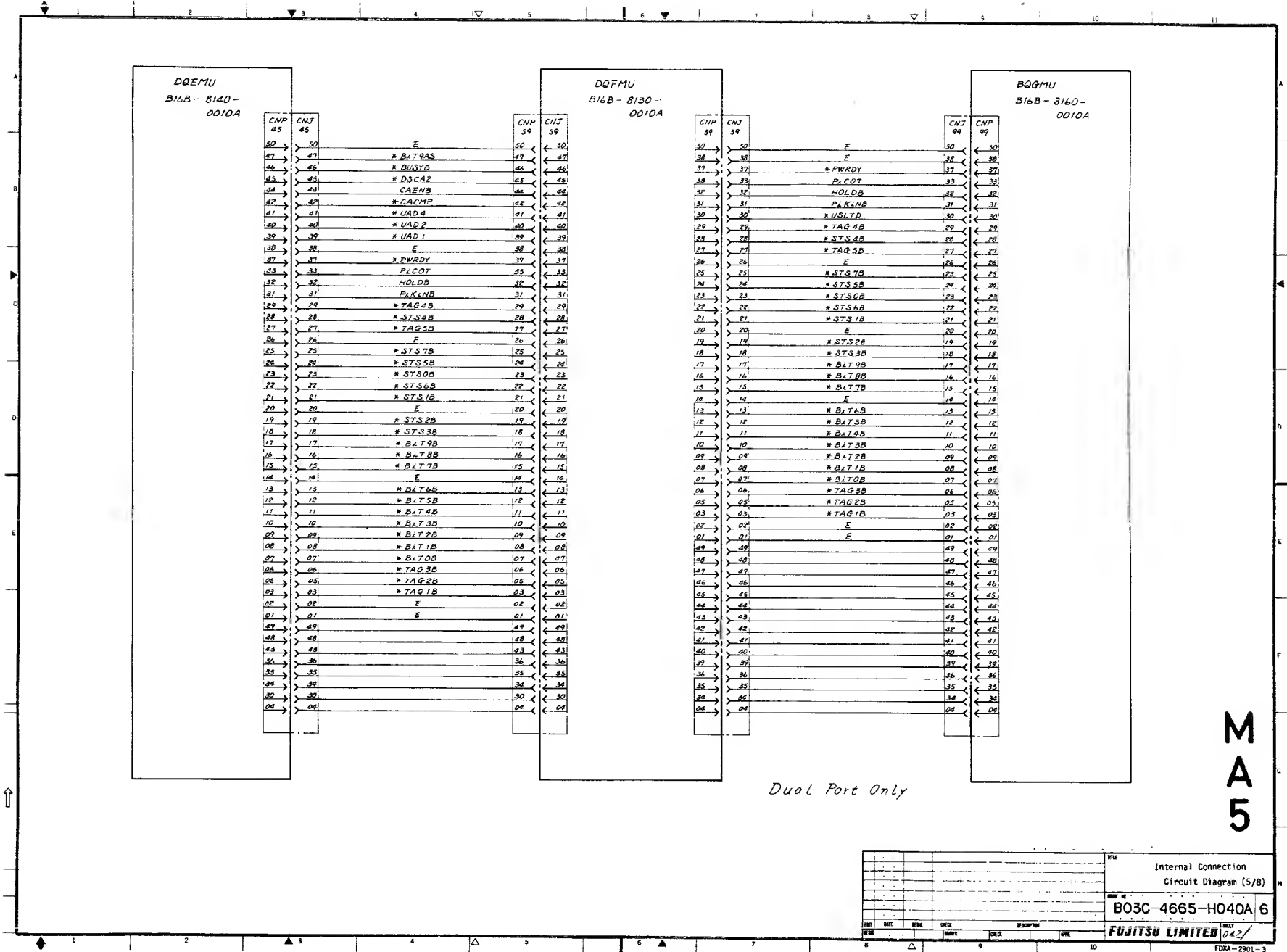
Basic Only

M  
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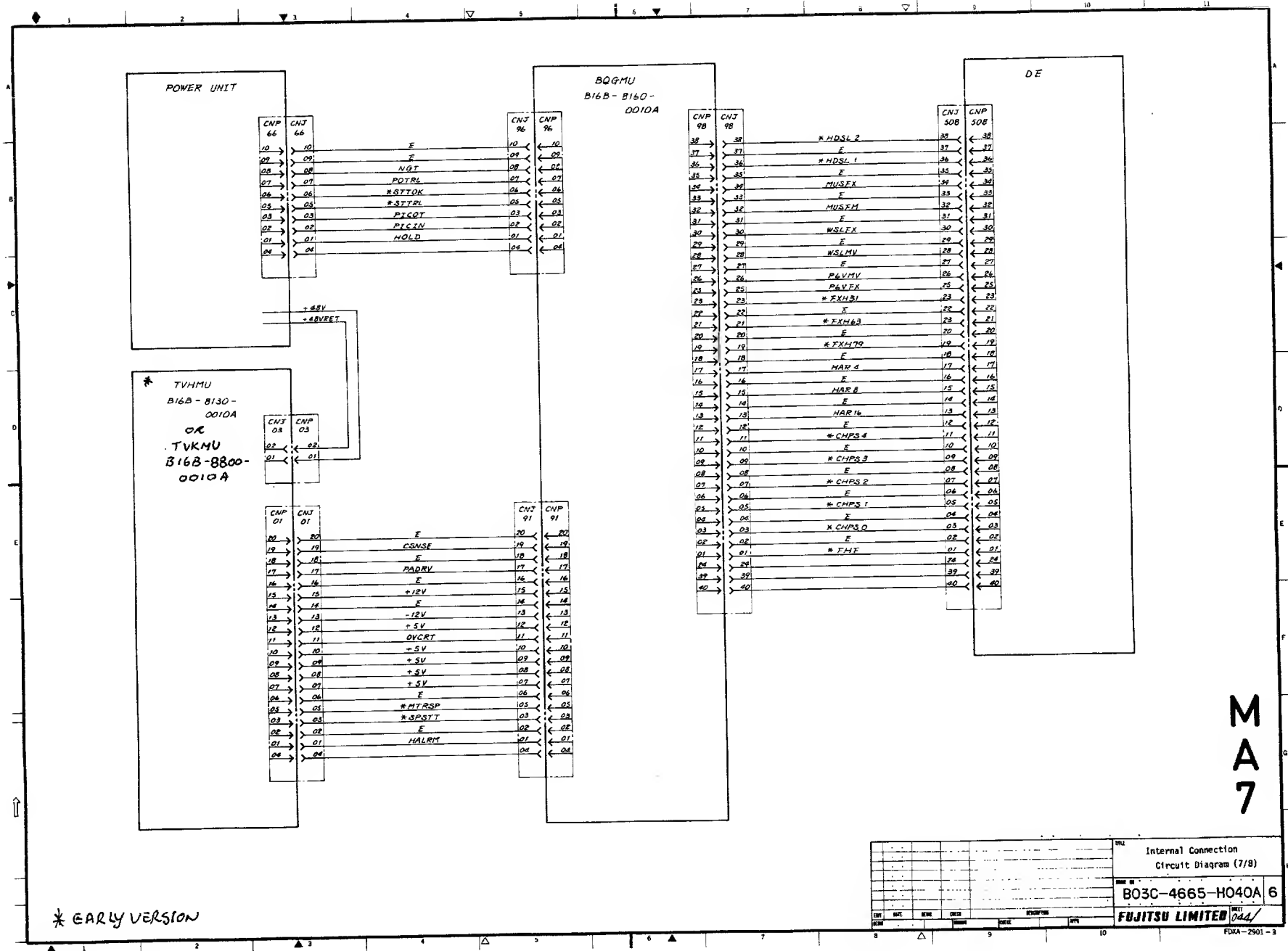
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| Internal Connection<br>Circuit Diagram (3/8) |  |  |  |
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| FUJITSU LIMITED                              |  |  |  |

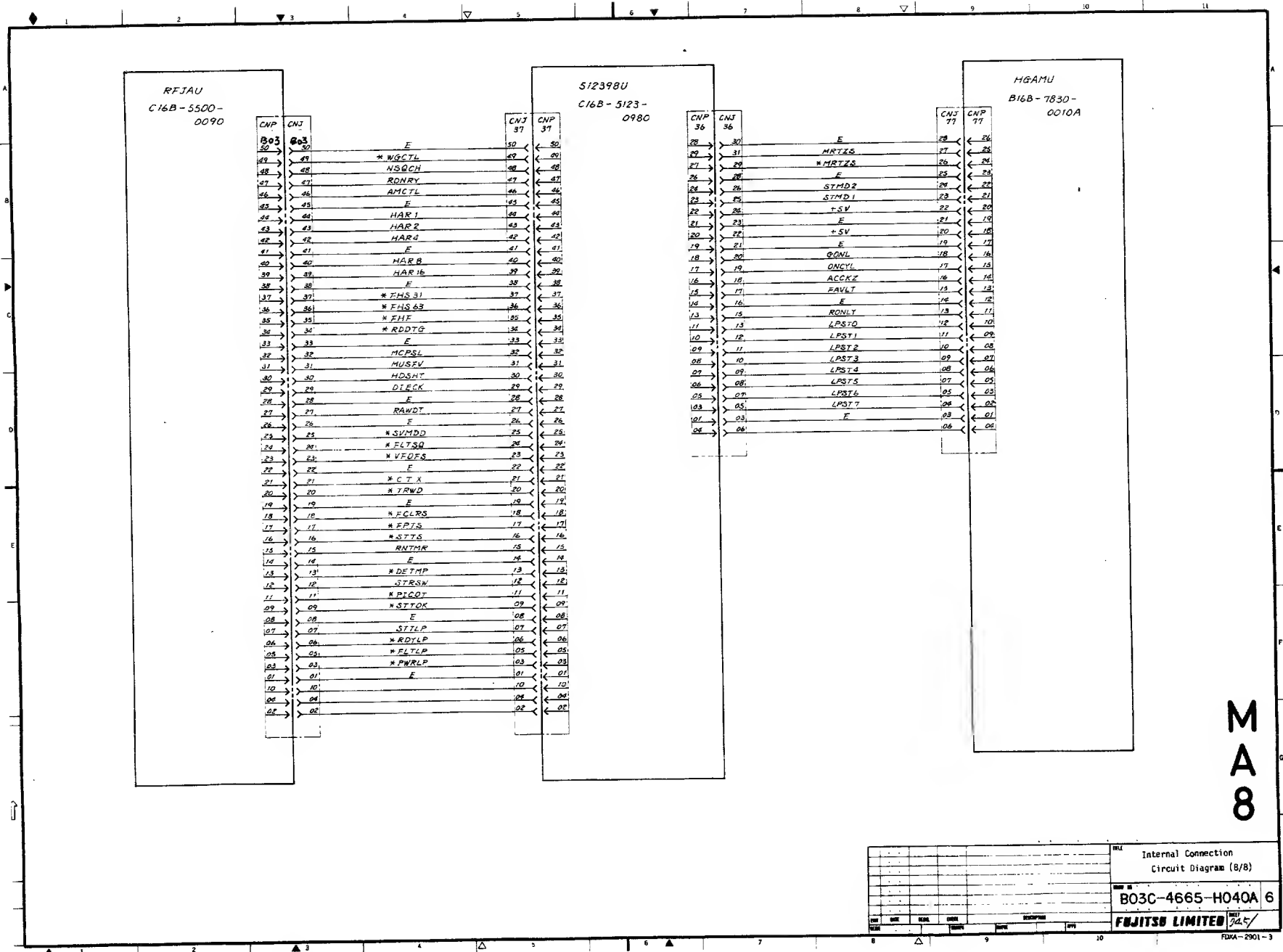
17-41



M  
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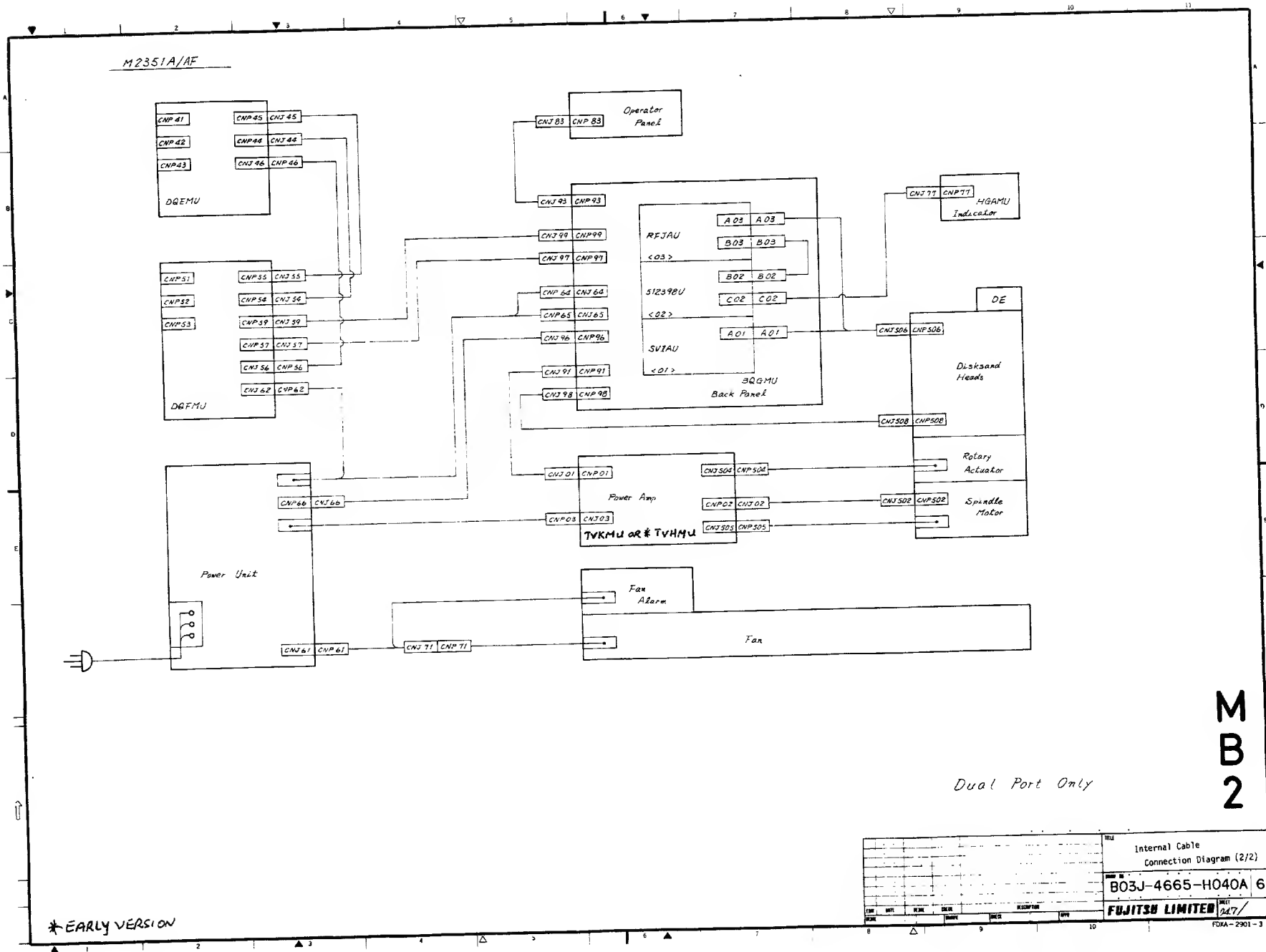












\*EARLY VERSION

Dual Port Only

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2



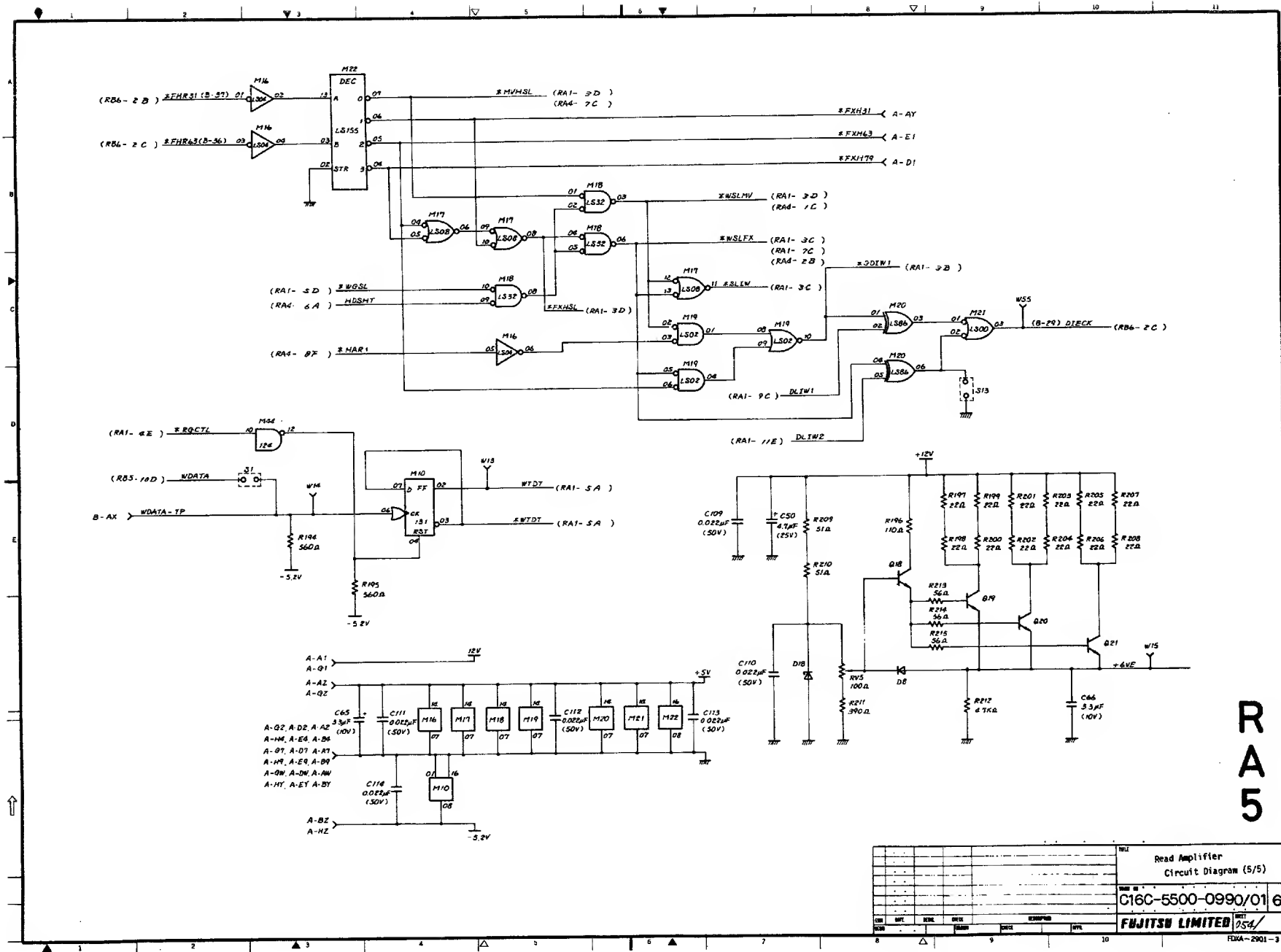








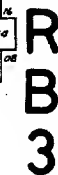




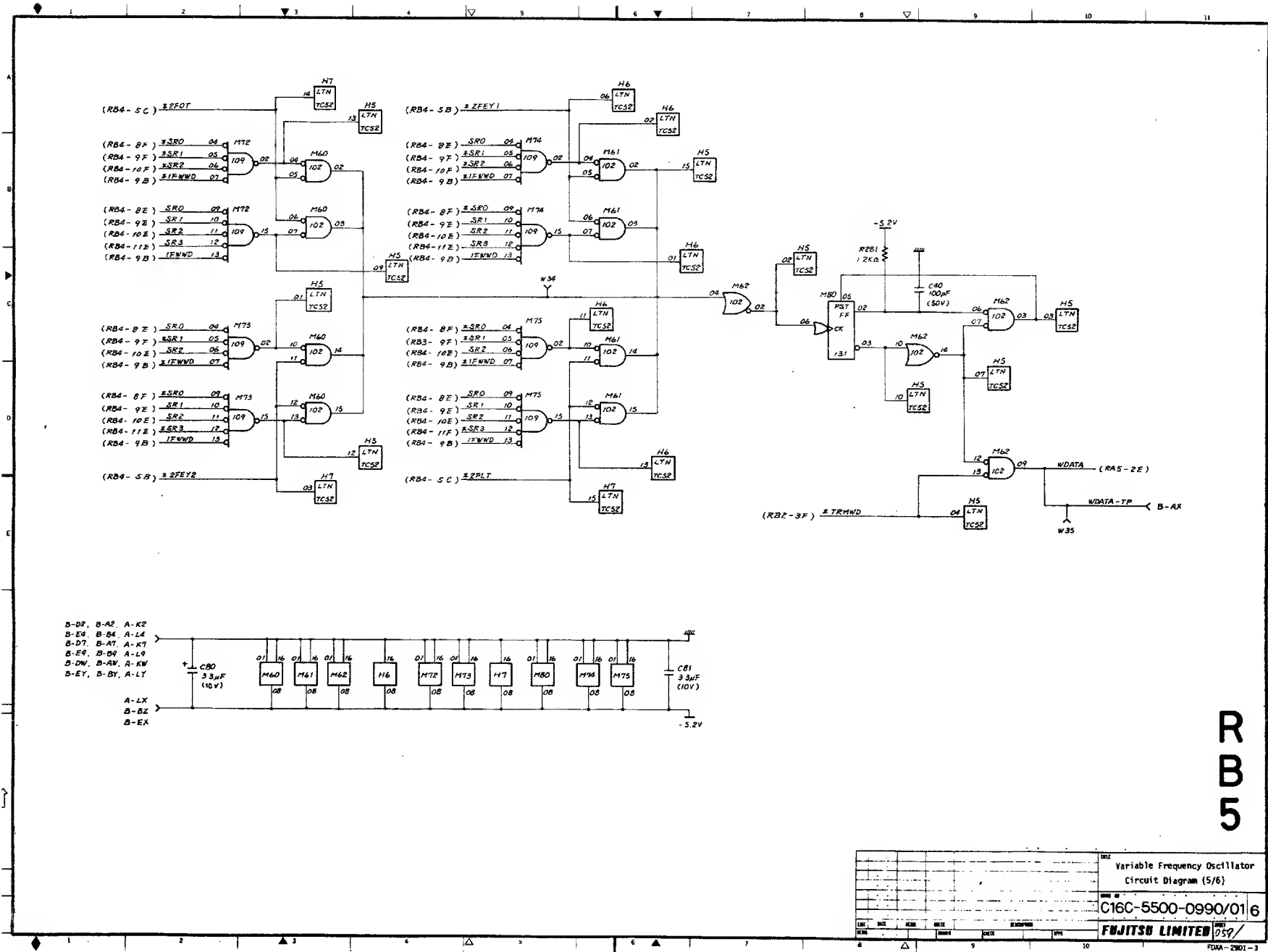




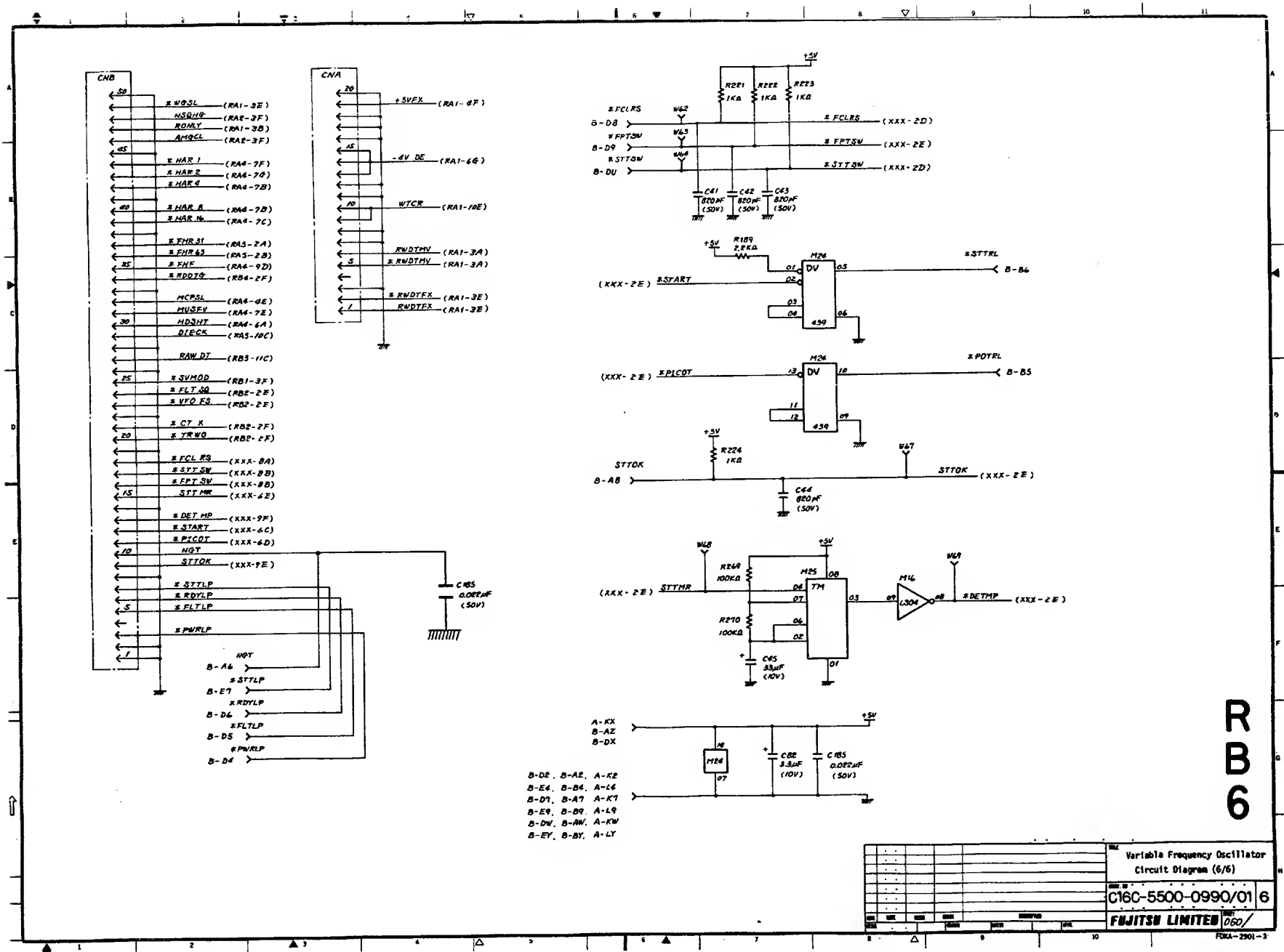


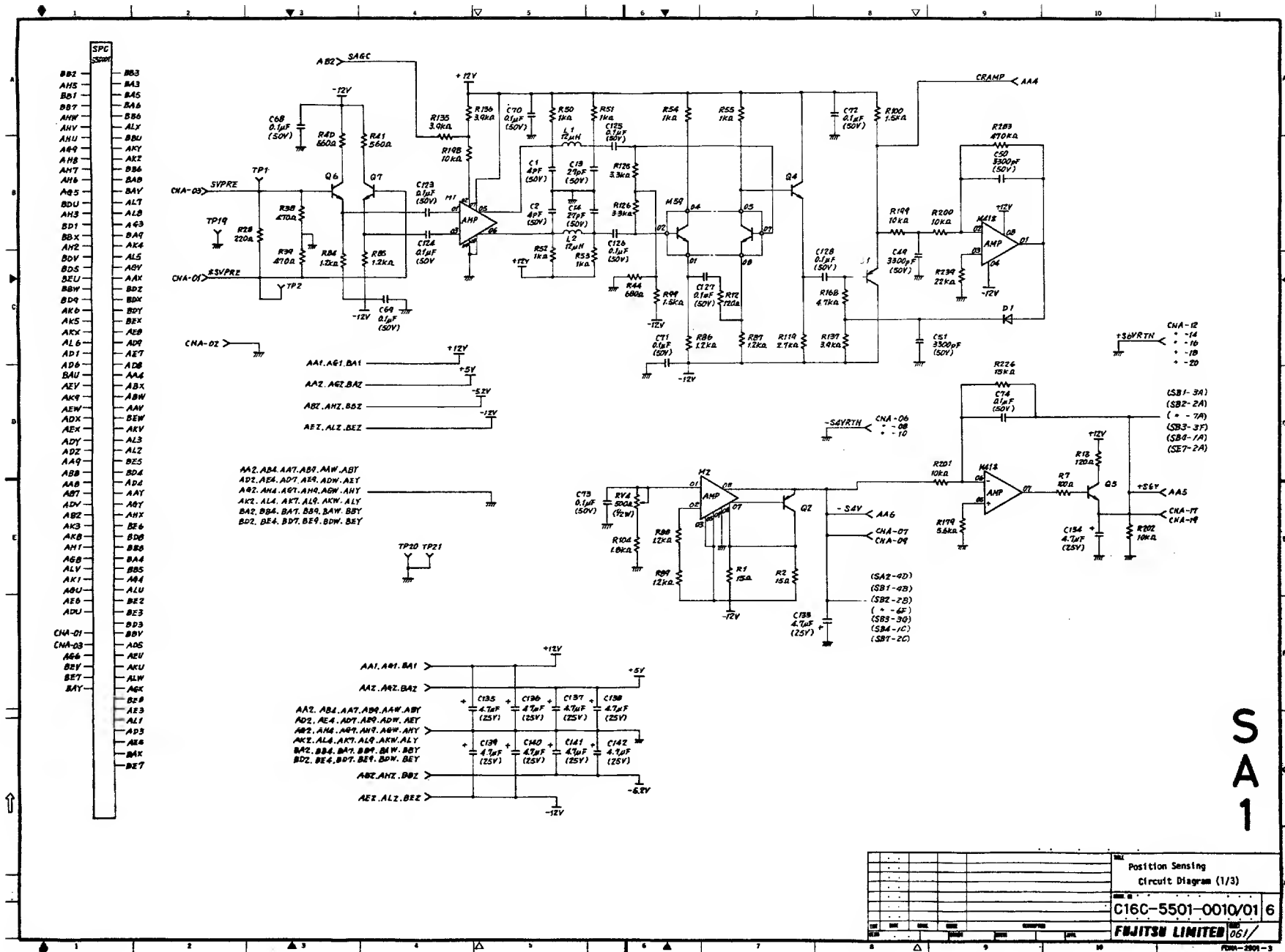






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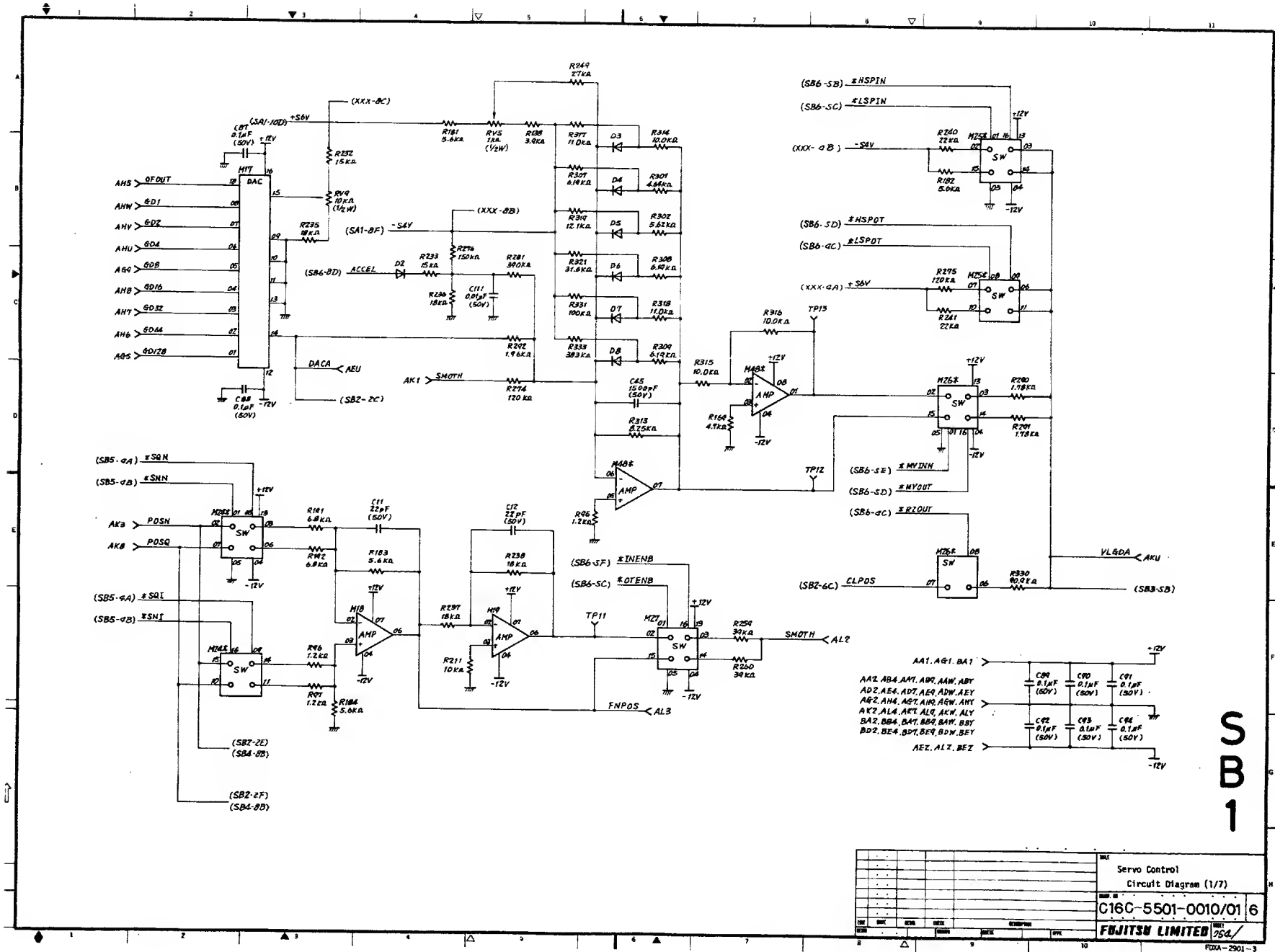












S B 1

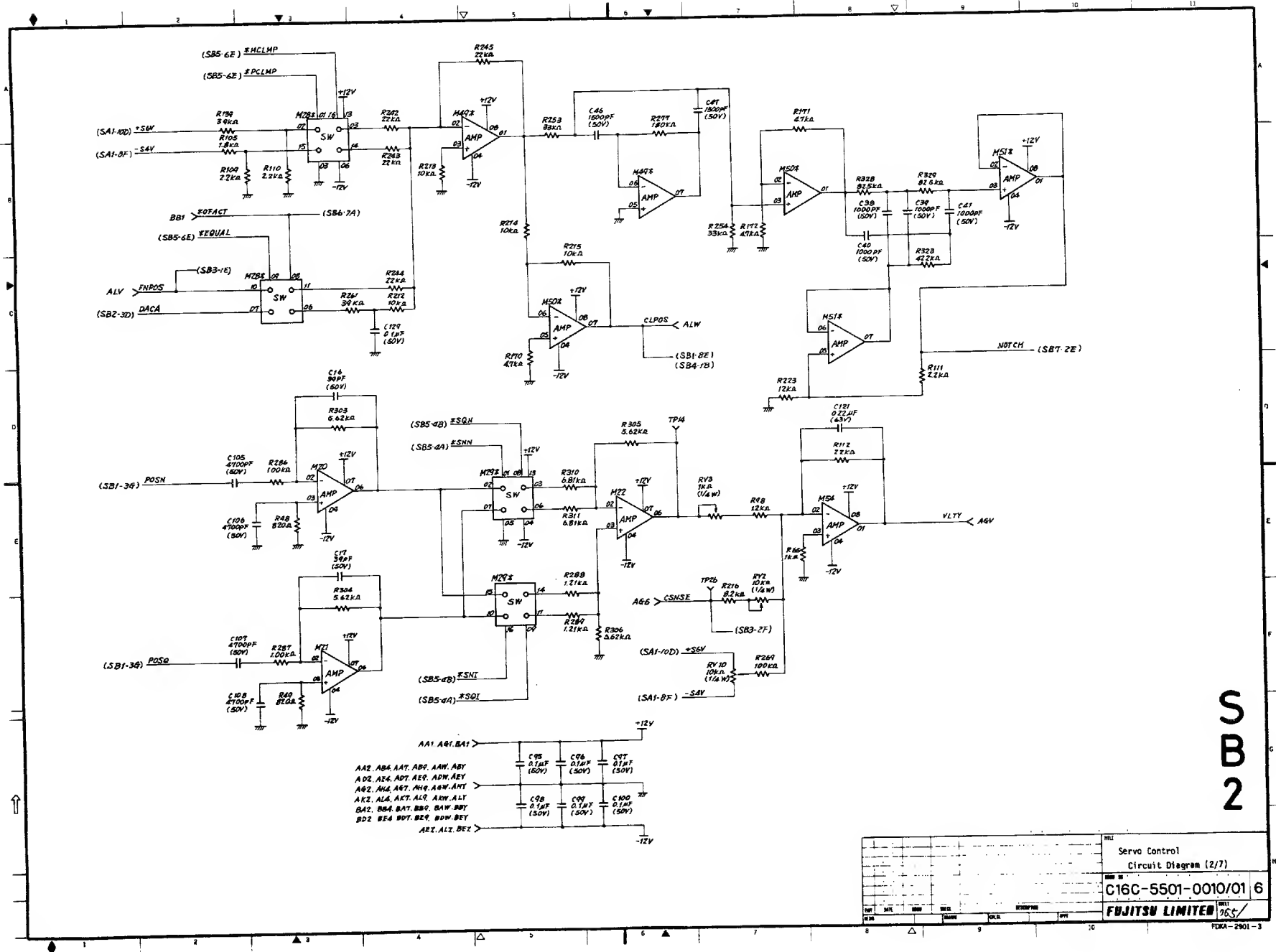
Servo Control  
Circuit Diagram (1/7)

C16C-5501-0010/01 6

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FDXA-2901-3







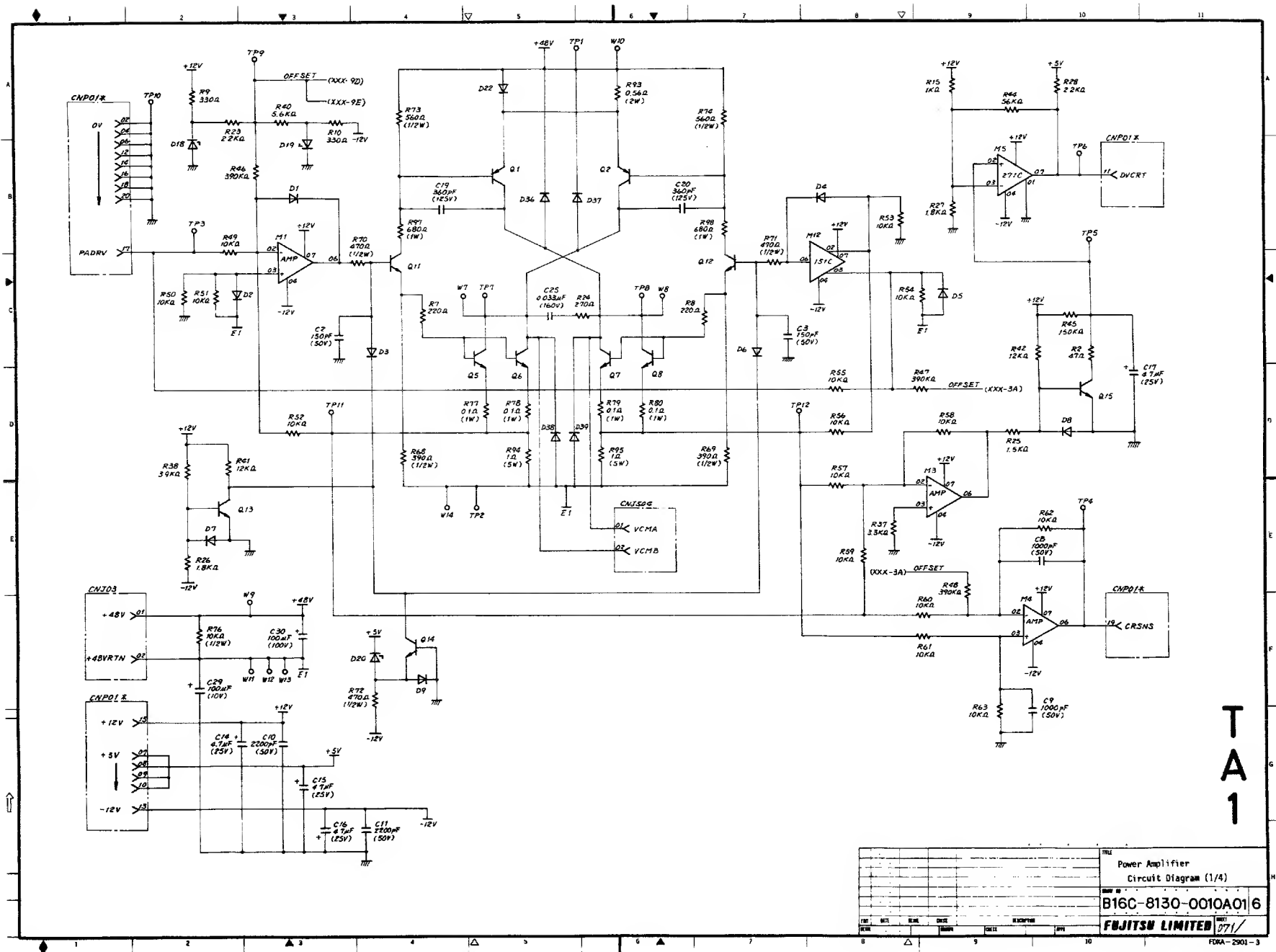
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|      |       |         |          |          |             |      |  |  |  | Servo Control<br>Circuit Diagram (4/7) |   |
|      |       |         |          |          |             |      |  |  |  | Part No.                               |   |
|      |       |         |          |          |             |      |  |  |  | C16C-5501-0010/01                      | 6 |
|      |       |         |          |          |             |      |  |  |  | <b>FUJITSU LIMITED</b><br>TOKYO JAPAN  |   |
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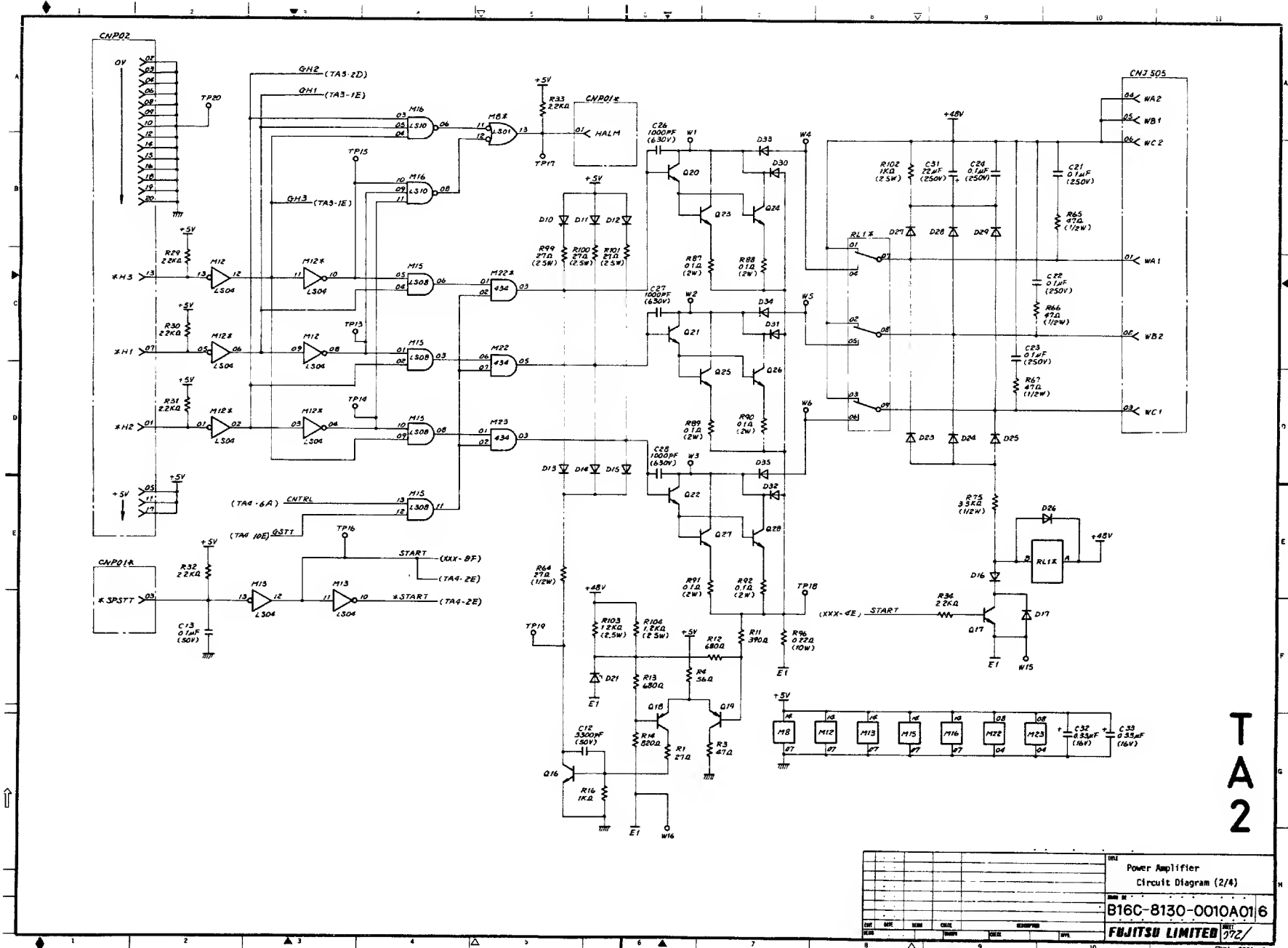


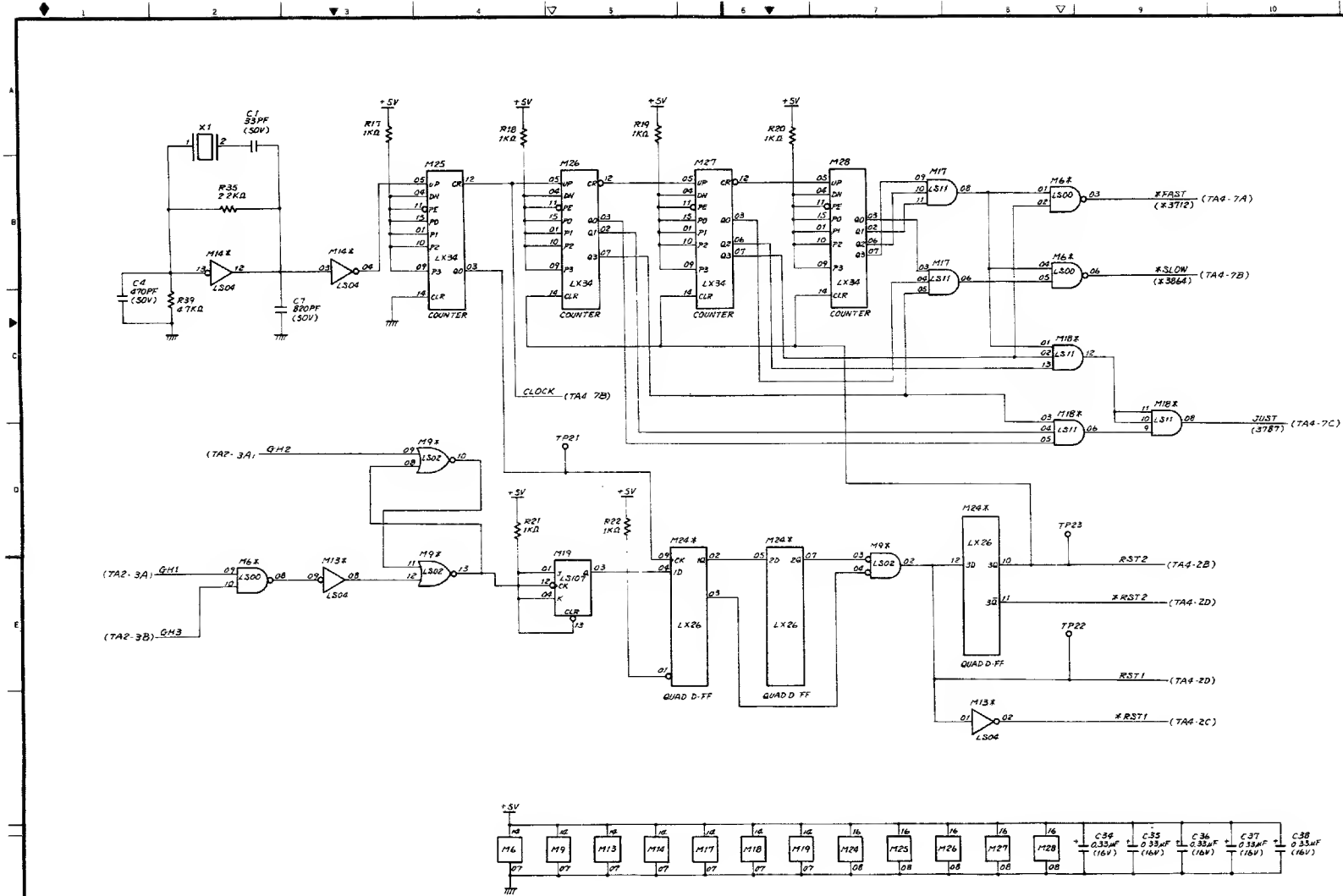






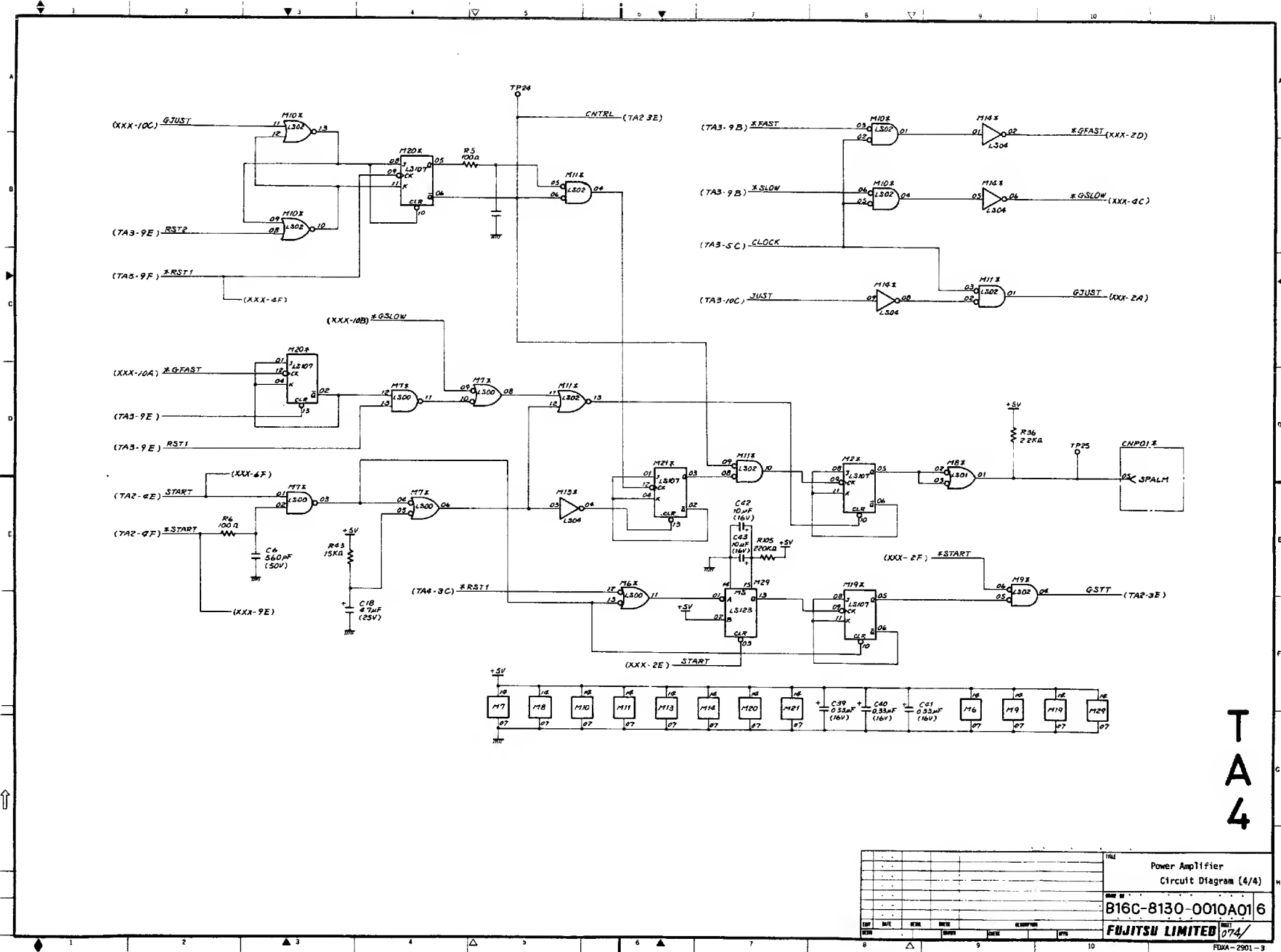






TA3

|  |  |  |  |                                          |  |
|--|--|--|--|------------------------------------------|--|
|  |  |  |  | Power Amplifier<br>Circuit Diagram (3/4) |  |
|  |  |  |  | B16C-8130-0010A016                       |  |
|  |  |  |  | FUJITSU LIMITED                          |  |
|  |  |  |  | FDMA-2901-3                              |  |



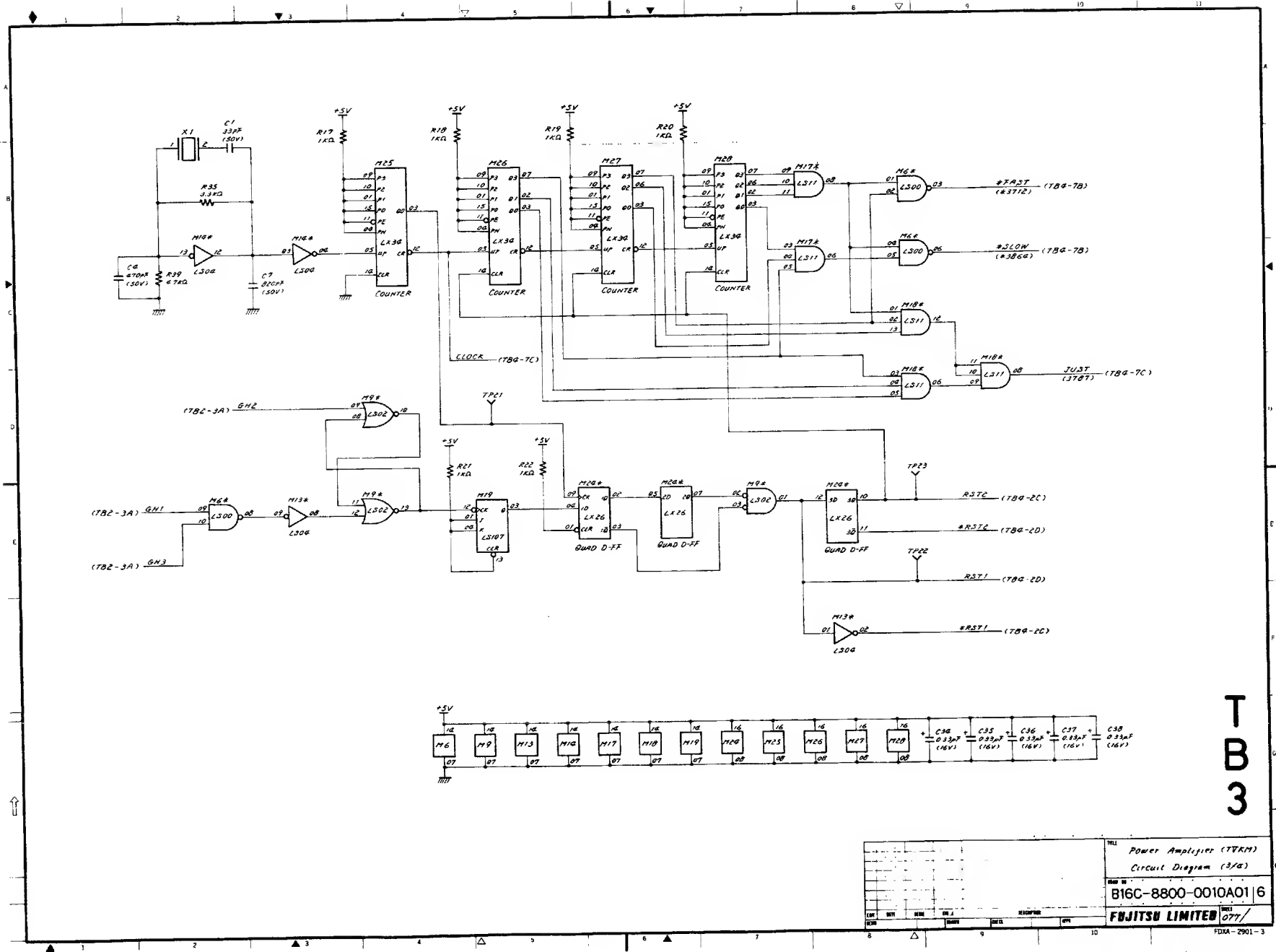
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17-77



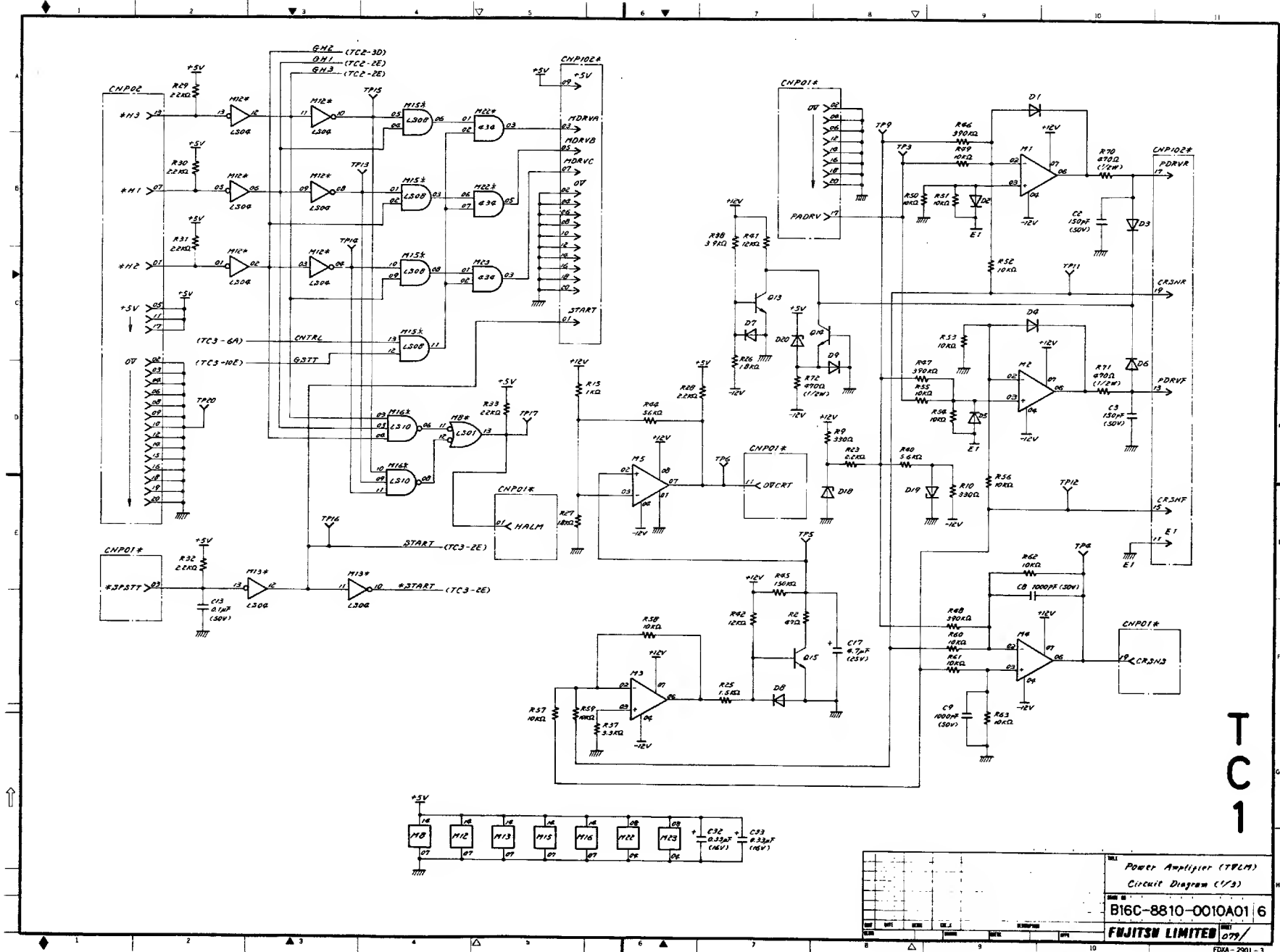
T B 3

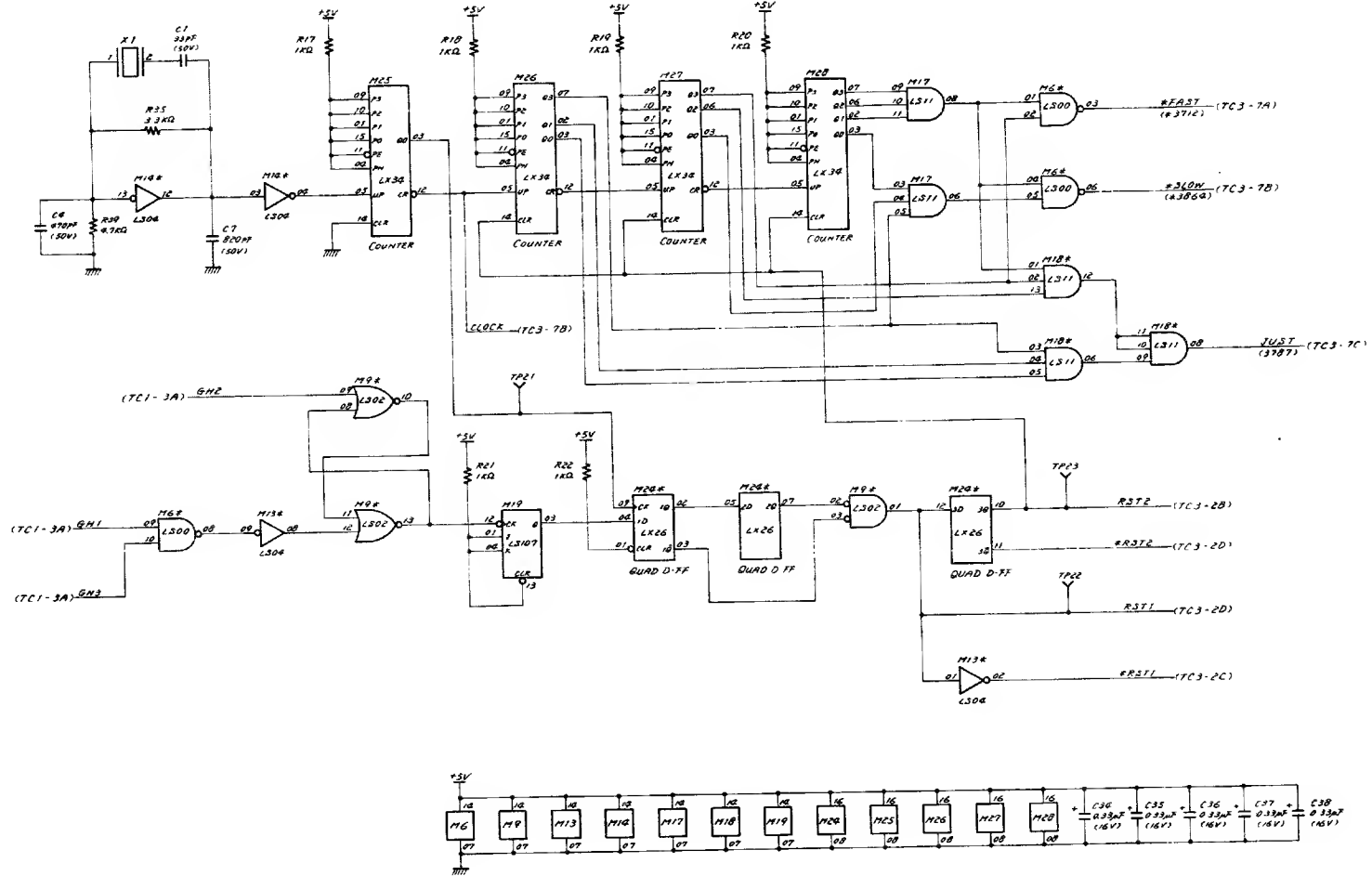
Power Amplifier (TTRM)  
Circuit Diagram (3/4)  
B16C-8800-0010A01 6  
FUJITSU LIMITED 077/

FDXA-2901-3



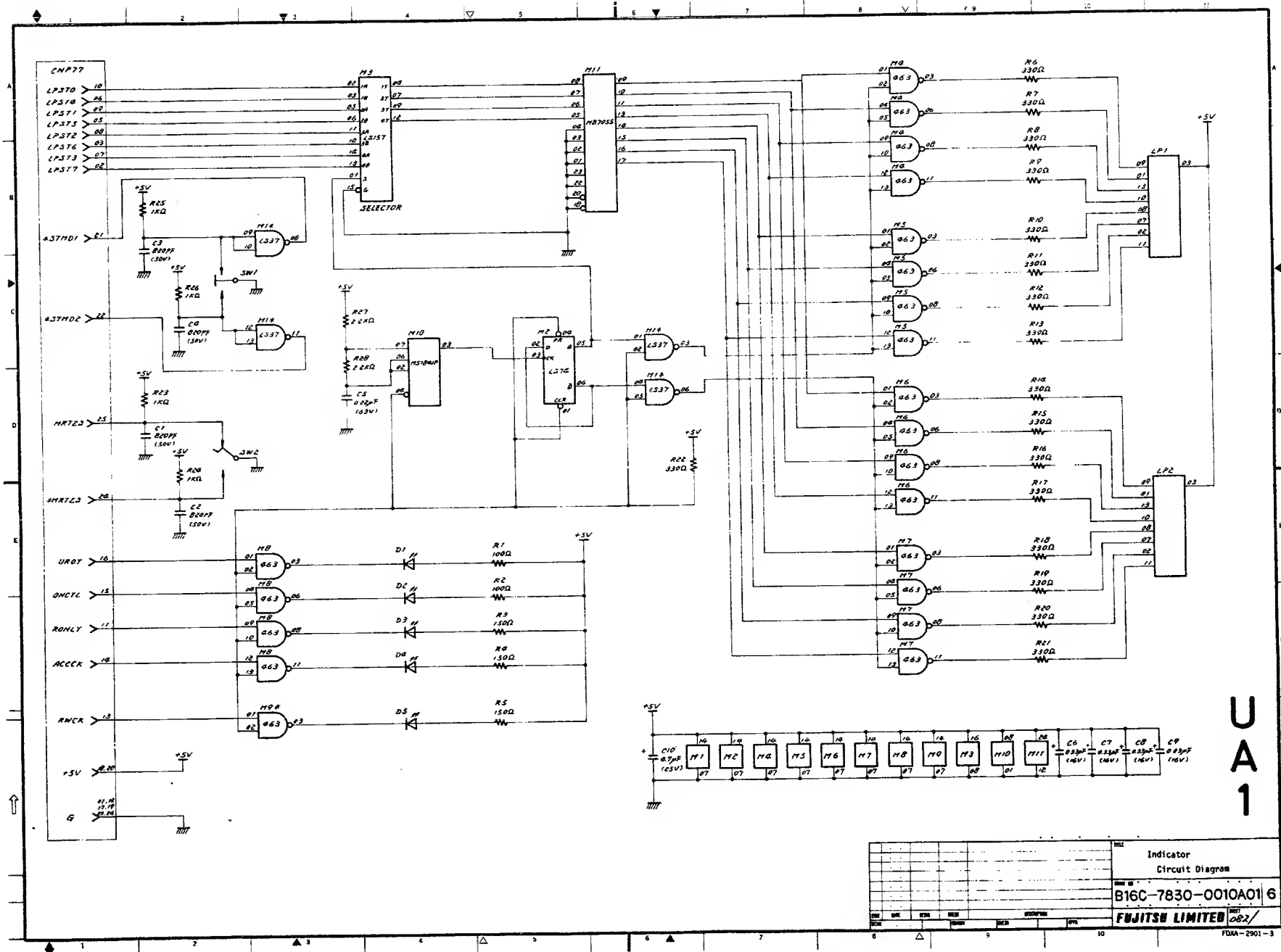


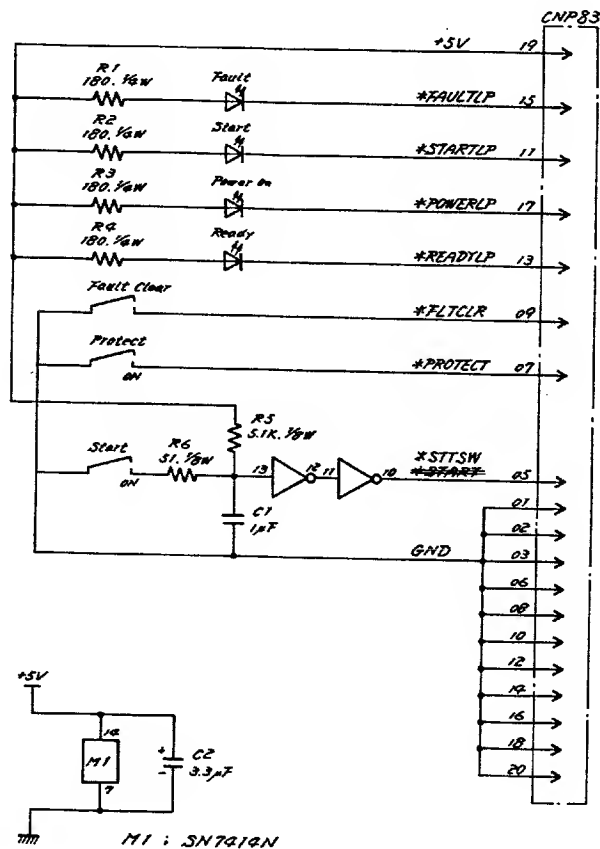






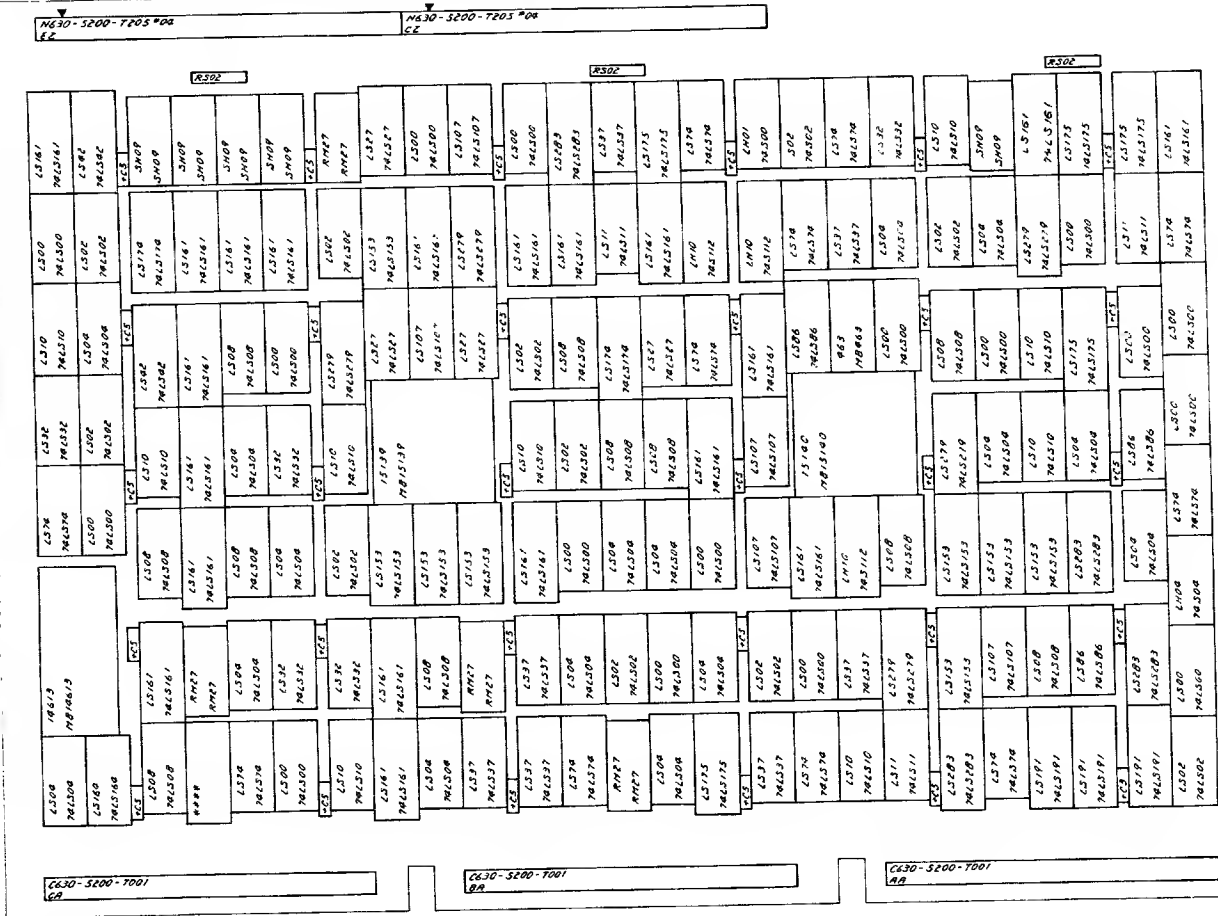
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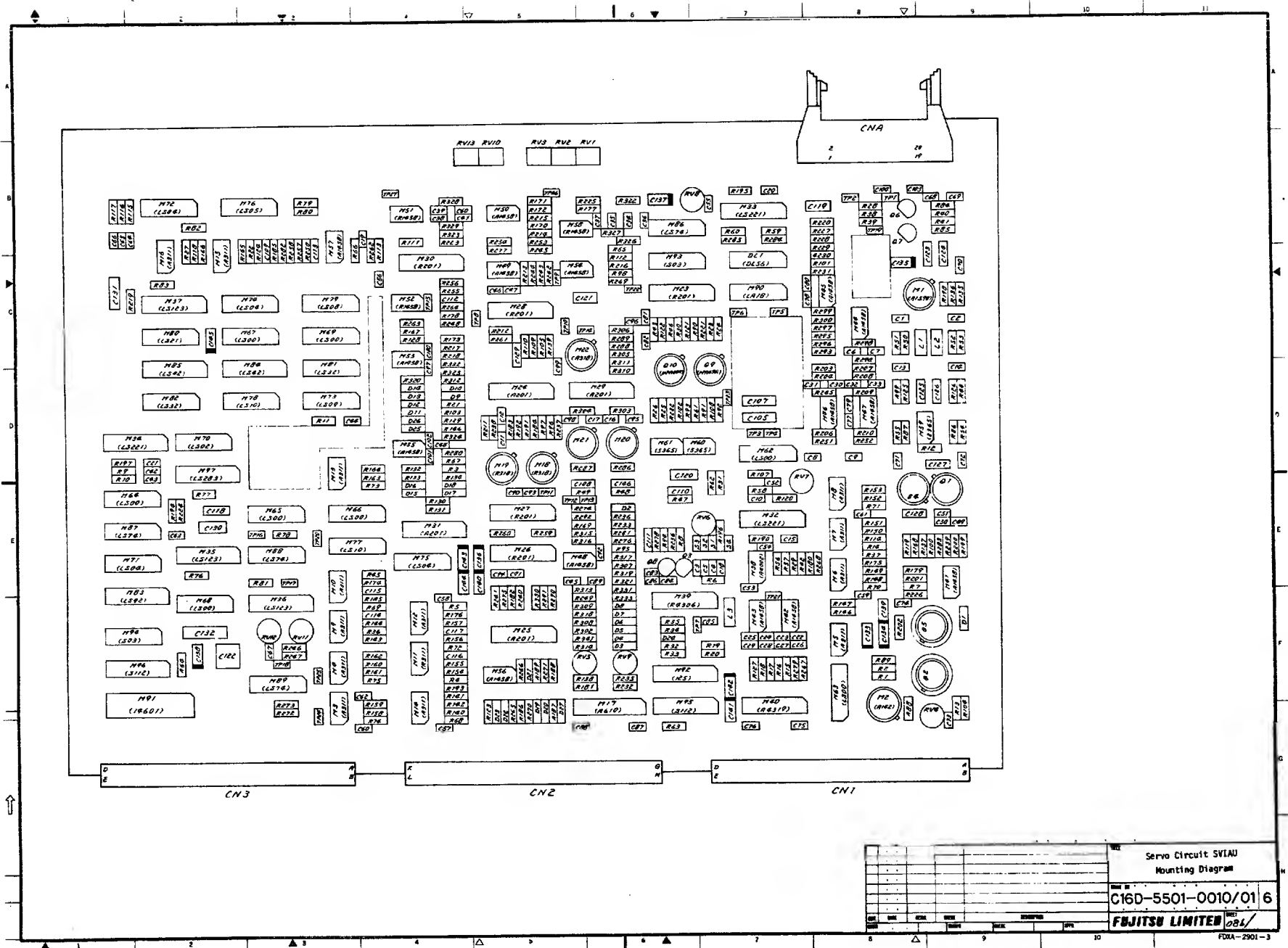
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|      |      |    |      | Operator Panel    |  |
|      |      |    |      | Circuit Diagram   |  |
|      |      |    |      | PART NO           |  |
|      |      |    |      | N86C-3346-0001A 6 |  |
|      |      |    |      | FUTURES LIMITED   |  |
|      |      |    |      | 083/              |  |
| REV. | DATE | BY | CHKD | DESCRIPTION       |  |
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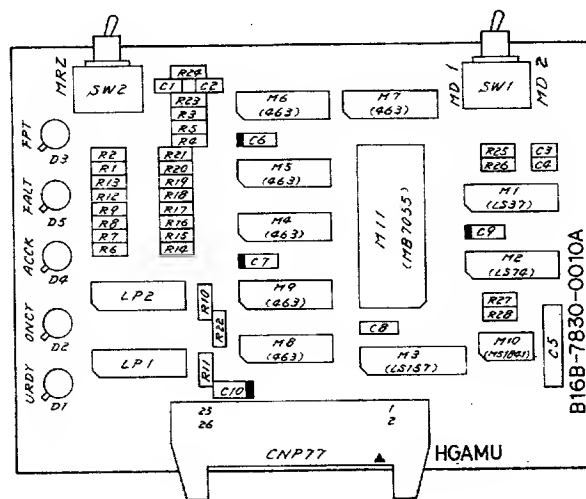
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| Logic Circuit 51238U<br>Mounting Diagram |      |    |     |     |          |      |    |     |     |
| C16D-5123-0980/016                       |      |    |     |     |          |      |    |     |     |
| FUJITSU LIMITED 089/                     |      |    |     |     |          |      |    |     |     |
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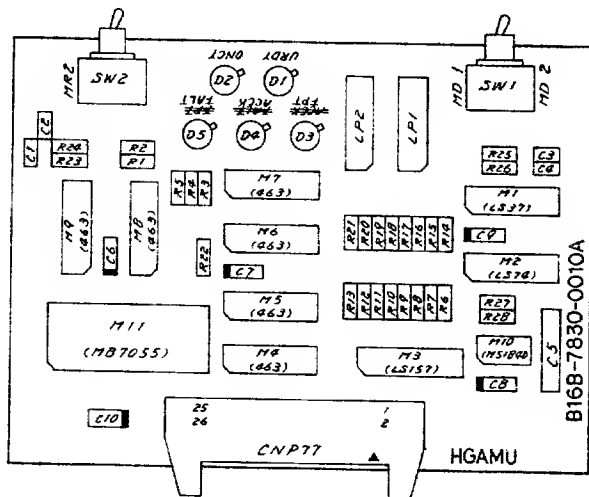




17-87



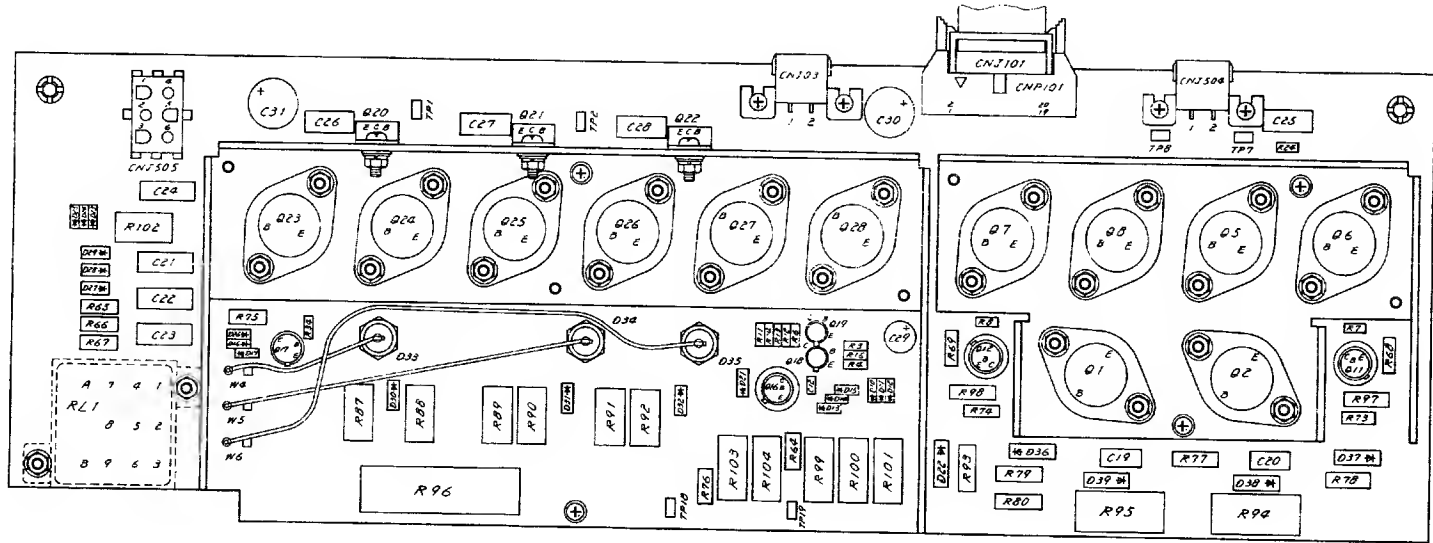
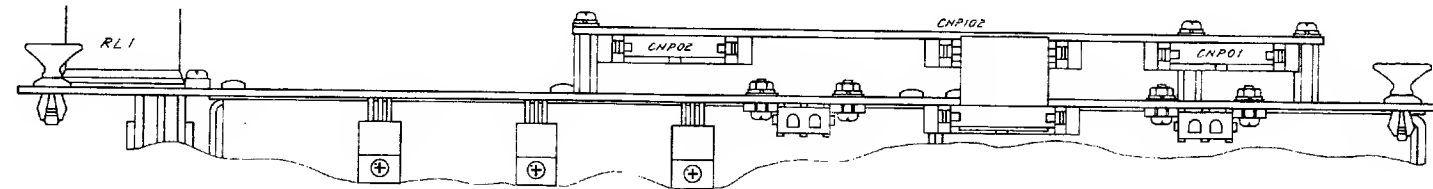
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|        |      |        |       |             |       |        |  |  |  | DRAWING NO.<br>B16D-7830-0010A01                     |  |
|        |      |        |       |             |       |        |  |  |  | 6                                                    |  |
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| REVISE |      |        |       | DRAWING     | CHECK | APPROV |  |  |  |                                                      |  |



|  |  |  |  |             |  |                         |  |
|--|--|--|--|-------------|--|-------------------------|--|
|  |  |  |  | TITLE       |  | Indicator Circuit HGAMU |  |
|  |  |  |  |             |  | Mounting Diagram        |  |
|  |  |  |  | DRAWN BY    |  | B16D-7830-0010A02 6     |  |
|  |  |  |  | CHECKED BY  |  | FUJITSU LIMITED         |  |
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| NO | Q11 Q12 Q16                                     | CN17-916P10 |
|----|-------------------------------------------------|-------------|
| 1  | Q11 Q12 Q16                                     | -916P107    |
| 2  | Q17 Q18                                         | -916P107    |
| 3  | Q19 Q20                                         | -916P107    |
| 4  | Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28                 | -916P107    |
| 5  | Q29 Q30 Q31 Q32 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40 | -916P107    |

| NO | Q11 Q12 Q16                                     | CN17-916P10 |
|----|-------------------------------------------------|-------------|
| 1  | Q11 Q12 Q16                                     | -916P107    |
| 2  | Q17 Q18                                         | -916P107    |
| 3  | Q19 Q20                                         | -916P107    |
| 4  | Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28                 | -916P107    |
| 5  | Q29 Q30 Q31 Q32 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40 | -916P107    |

Power Amplifier (TVM)

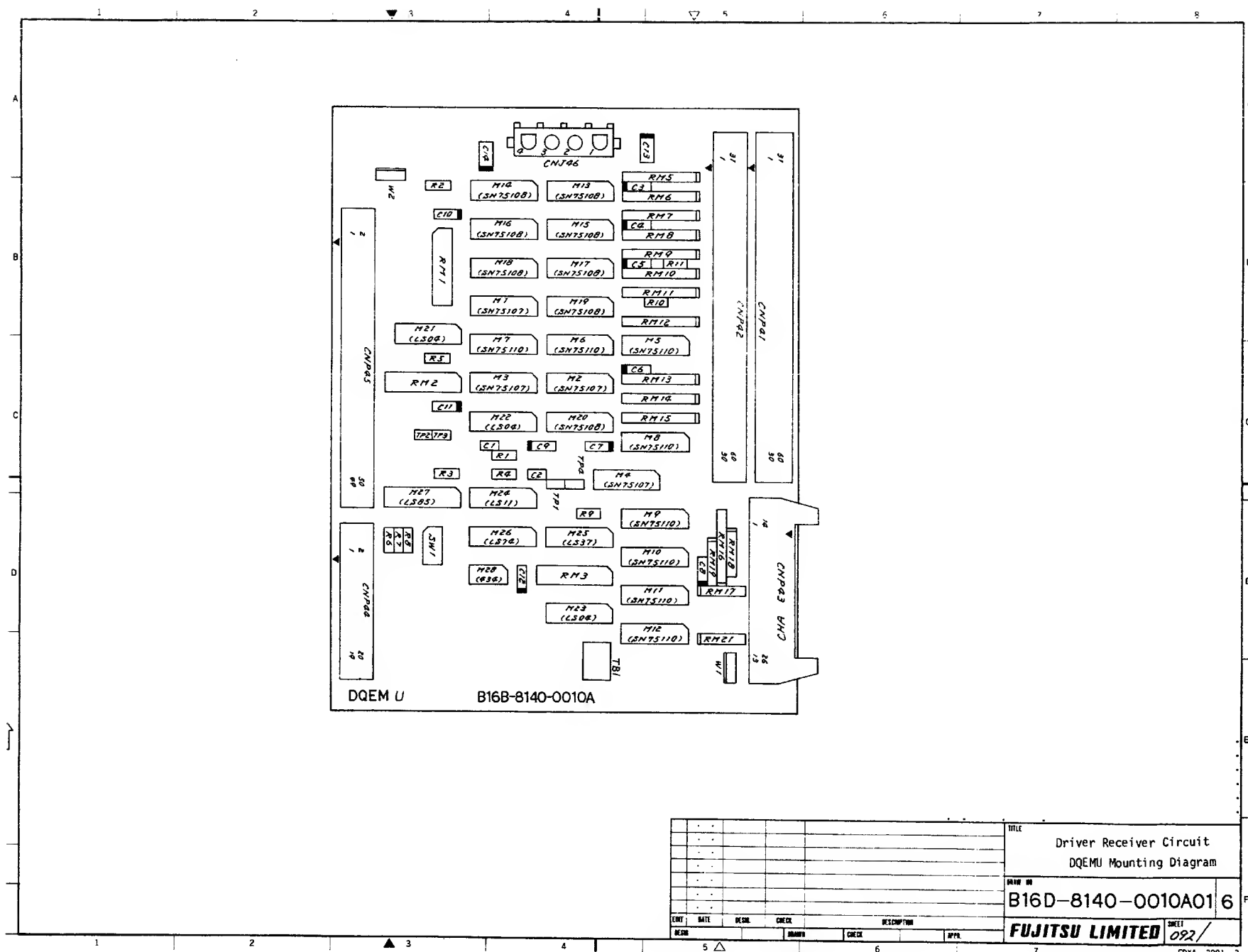
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FUJITSU LIMITED 090/

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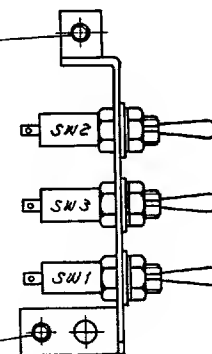
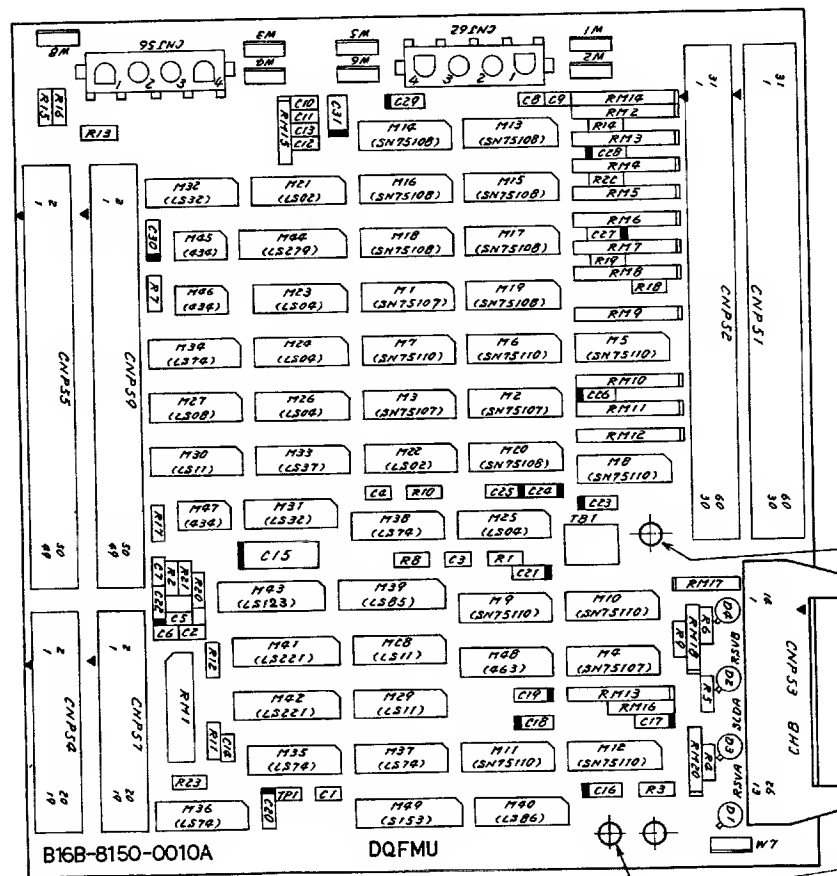
17-91





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17-93



| TITLE                   |      |    |      |             |      |
|-------------------------|------|----|------|-------------|------|
| Driver Receiver Circuit |      |    |      |             |      |
| DQFMU Mounting Diagram  |      |    |      |             |      |
| DRAWING NO.             |      |    |      |             |      |
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| Fujitsu Limited         |      |    |      |             |      |
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|                         |      |    |      |             |      |
|                         |      |    |      |             |      |



## 17.2 ABBREVIATIONS

|   | Abbreviation    | Full Name                           |
|---|-----------------|-------------------------------------|
| A | ABN             | Abnormal                            |
|   | ABSLD           | A/B Channel Selected                |
|   | ACCCK           | Access Check                        |
|   | ACCEL           | Acceleration                        |
|   | ACCST           | Access Start                        |
|   | ACLMP           | Acceleration Clamp                  |
|   | ACMOD           | Access Mode                         |
|   | ACSTP           | Access Start Pulse                  |
|   | ACTMO           | Access Time Out                     |
|   | AGC             | Automatic Gain Control              |
|   | AGC-TP          | Automatic Gain Control - Test Point |
|   | AGCOT1 ~ AGCOT2 | Automatic Gain Control Output 1 ~ 2 |
|   | ALWDF           | Allow Difference                    |
|   | AMCTL           | Address Mark Control                |
|   | AMENB           | Address Mark Enable                 |
|   | AMFD            | Address Mark Found                  |
|   | AMFD3           | Address Mark Found 3                |
|   | AMGCL           | Address Mark Gate Control           |
|   | AMRD            | Address Mark Read                   |
|   | AM8BT           | Address Mark Round 8-Byte           |
|   | ANYRZ           | Any Rezero                          |
|   | ATTEN           | Attention                           |
| B | BDINS           | Bad Initial Status                  |
|   | BIBIH           | Bibration Inhibit                   |
|   | BIBIN           | " "                                 |
|   | BITL2           | Bit Latch 2                         |
|   | BIT0 ~ BIT9     | Bit 0 ~ 9                           |
|   | BIT0A ~ BIT9A   | Bit 0 ~ 9 (Channel-A)               |
|   | BIT0B ~ BIT9B   | Bit 0 ~ 9 (Channel-B)               |
|   | BIT0H ~ BIT9H   | Bit 0 ~ 9 High                      |
|   | BIT0L ~ BIT9L   | Bit 0 ~ 9 Low                       |
|   | BIT9AS          | Bit 9 (Channel-A Priority Select)   |
|   | BIT9BS          | Bit 9 (Channel-B Priority Select)   |
|   | BIT9S           | Bit 9 (Priority Select)             |
|   | BTC1 ~ BTC8     | Bit Counter 1 ~ 8                   |
|   | BUSY            | Busy                                |
|   | BUSYA/BUSYB     | Busy (Channel-A/B)                  |
|   | BUSYH/BUSYL     | Busy High/Low                       |
|   | BYCL            | Byte Clock                          |

|   | Abbreviation  | Full Name                       |
|---|---------------|---------------------------------|
| C | CACMP         | Channel-A Compare               |
|   | CAENB         | Channel-A Enable                |
|   | CAPVL         | Capture Velocity                |
|   | CARSV         | Channel-A Reserved              |
|   | CAR1 ~ CAR2   | Cylinder Address Register 1 ~ 2 |
|   | CASLD         | Channel-A Selected              |
|   | CBCMP         | Channel-B Compare               |
|   | CBENB         | Channel-B Enable                |
|   | CBRSV         | Channel-B Reserved              |
|   | CBSLD         | Channel-B Selected              |
|   | CHPS0 ~ CHPS4 | Chip Select 0 ~ 4               |
|   | CKGDB         | Check Guard Band                |
|   | CLCK          | Clock                           |
|   | CLOCK         | Clock                           |
|   | CLPOS         | Clamped Position                |
|   | CL1 ~ CL219   | Clock Counter 1 ~ 219           |
|   | CNCT          | Connect                         |
|   | CNTRL         | Control                         |
|   | CORSE         | Coarse                          |
|   | CRAMP         | Carrier Amp                     |
|   | CRSNS         | Current Sense                   |
|   | CSNSE         | Current Sense                   |
|   | CTINT         | Counter Initialize              |
|   | CTLCK         | Control Check                   |
|   | CTX           | Count X Signal                  |
|   | CTXECL        | Count X ECL Level               |
|   | CT1 ~ CT15    | Count 1 ~ Count 15              |
|   | CT15P         | Count 15 Pulse                  |
| D | DACA          | Digital to Analog Converter A   |
|   | DAMFD         | Delayed Address Mark Found      |
|   | DECFR         | Decrease Frequency              |
|   | DETMP         | DE Timer Pulse                  |
|   | DFCL          | Difference Clock                |
|   | DFGT1 ~ DFGT2 | Difference Gate 1 ~ 2           |
|   | DFZR          | Difference Zero                 |
|   | DIECK         | Delta I Write Check             |
|   | DIFF          | Differentiator                  |
|   | DIFF-TP       | Differentiator - Test Point     |
|   | DISAS         | Disable Channel-A Switch        |
|   | DISBS         | Disable Channel-B Switch        |
|   | DISCA         | Disable Channel-A               |
|   | DISCB         | Disable Channel-B               |
|   | DL DAM        | Delayed Address Mark            |
|   | DLDDT         | Delayed Data                    |
|   | DLIW1 ~ DLIW2 | Delta I Write 1 ~ 2             |
|   | DLIXW         | Delayed Index Window            |

|   | Abbreviation                                                                                                                                                   | Full Name                                                                                                                                                                                                                                                                                                                                                                                             |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D | DLMS<br>DLRGC<br>DLZRX<br>DLZRX-TP<br>DSCA/DSCB<br>DSCA2<br>DSCB2<br>DSQCK<br>DSQL1 ~ DSQL4<br>DTFSC<br>DTFSP<br>DTGT<br>DTGT-TP<br>D1 ~ D512<br>D1440<br>D16S | Delayed Motor at Speed<br>Delayed Read Gate Control<br>Delayed Zero Cross Data<br>Delayed Zero Cross Data - Test Point<br>Disable Channel-A/B<br>Disable Channel-A2<br>Disable Channel-B2<br>DE Sequence Check<br>DE Sequence Latch 1 ~ 4<br>Data Fast Sync.<br>Data Fast Sync. Pulse<br>Data Gate<br>Data Gate - Test Point<br>Difference 1 ~ 512<br>Difference 144 Over<br>Difference 16 or Smaller |
| E | EDEAT<br>ENBAS<br>ENBBS<br>ENDAC<br>ENDDC<br>EN11S ~ EN60S<br>EQUAL<br>EQULE<br>ERPOS<br>EVEN1 ~ 2<br>E05MS<br>E5MS                                            | Enable DE Attention<br>Enable Channel-A Switch<br>Enable Channel-B Switch<br>End Accelerate<br>End Decelerate<br>End 11 Seconds ~ End 60 Seconds<br>Equal<br>Equal<br>Error Position<br>Even 1 ~ 2<br>End 5 Micro-Seconds<br>End 5 Milli-Seconds                                                                                                                                                      |
| F | FAST<br>FAULT<br>FCARO ~ FCAR3<br>FCLRC<br>FCLRS<br>FG<br>FHDSL<br>FHF<br>FHR31 ~ FHR63<br>FHS31 ~ FHS95                                                       | Fast<br>Fault<br>Fix Cylinder Address Register 0 ~ 3<br>Fault Clear Command<br>Fault Clear Switch<br>Function Generator<br>Fixed Head Select<br>Fixed Head Feature<br>Fixed Head Register 31 ~ 63<br>Fixed Head Select 31 ~ 95                                                                                                                                                                        |

|   | Abbreviation                                                                                                                                                                                                                                                      | Full Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F | FHTG1<br>FLCLR<br>FLCRS<br>FLSQ<br>FLTLP<br>FLTSQ<br>FNPOS<br>FNVEL<br>FPTS<br>FPTSW<br>FSECL<br>FSYNC<br>FTCLR<br>FXHSL                                                                                                                                          | Fixed Heat Tag 1<br>Fault Clear<br>Fault Clear Switch<br>Filter Squelch<br>Fault Lamp<br>Filter Squelch<br>Fine Position<br>Fine Velocity<br>File Protect Switch<br>File Protect Switch<br>Fast Synchronization ECL<br>Fast Synchronization<br>Fault Clear<br>Fixed Head Select                                                                                                                                                                                                                                                                                       |
| G | GANGH<br>GATE1 ~ GATE4<br>GATRT<br>GBP1 ~ GBP2<br>GDIW1<br>GDSK3<br>GD1 ~ GD128<br>GENAC<br>GFAST<br>GHCMP<br>GHRZ<br>GH1 ~ GH3<br>GINDX<br>GJUST<br>GLNMD<br>GONL<br>GPAT<br>GRDBL<br>GRDNP<br>GSLOW<br>GSTT<br>GST3<br>GSYNC<br>GTAG1 ~ GTAG5<br>GTKXP<br>G1440 | Gated Any Go Home<br>Gate 1 ~ Gate 4<br>Gate Attention Reset<br>Guard Band Pattern 1 ~ 2<br>Gated I Write 1<br>Gated Difference Seek 3<br>Gated Difference 1 ~ 128<br>Gated End Accelerate<br>Gated Fast<br>Go Home Complete<br>Go Home or Rezero<br>Gated Hall Element 1 ~ 3<br>Gated Index<br>Gated Just<br>Gated Linear Mode<br>Gated On Line<br>Gated Pattern<br>Guard Band Latch<br>Gated Read Down Pulse<br>Gated Slow<br>Gated Start<br>Gated State 3<br>Gated Synchronous Pulse<br>Gated Tag 1 ~ 5<br>Gated Track Crossing Pulse<br>Gated Difference 144 Over |

|   | Abbreviation                                                                                                                                                                             | Full Name                                                                                                                                                                                                                                                                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H | HALRM<br>HAR1 ~ HAR16<br>HA1 ~ HA16<br>HBYCL<br>HDGAN<br>HDGAN-TP<br>HDSHT<br>HDSL1 ~ HDSL2<br>HOLD<br>HOLDB<br>HSHCK<br>HSPIN<br>HSPOT<br>HVLST<br>H1 ~ H3                              | Hall Alarm<br>Head Address Register 1 ~ 16<br>Head Address 1 ~ 16<br>Half Byte Clock<br>Head Gain<br>Head Gain-Test Point<br>Head Short<br>Head Select 1 ~ 2<br>Hold<br>Hold Channel-B<br>Head Short Check<br>High Speed In<br>High Speed Out<br>High Velocity Set<br>Hall Element 1 ~ 3                                                                                                     |
| I | IDXCK<br>IHRSV<br>IHTAG<br>INCFR<br>INDSQ<br>INDYG<br>INDXH/INDXL<br>INDXP<br>INENB<br>INHRC<br>INHSQ<br>INLFS<br>INN<br>INSTG<br>INTEG<br>IS1 ~ IS128<br>IXCKG<br>IXCKL<br>IXMRK<br>IXW | Index Check<br>Inhibit Reserve<br>Inhibit Tags 4 and 5<br>Increase Frequency<br>Inhibit DE Sequence<br>Index Gate<br>Index High/Low<br>Index Pulse<br>Inner Enable<br>Inhibit Recycle<br>Inhibit Sequencer<br>Initial Fast Sync<br>Inner<br>Initial State Good<br>Integrated Position<br>Index Sector Counter 1 ~ 128<br>Index Check Gate<br>Index Check Latch<br>Index Mark<br>Index Window |
| J | JUST                                                                                                                                                                                     | Just                                                                                                                                                                                                                                                                                                                                                                                         |

|   | Abbreviation                                                                                                                                                                                      | Full Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| L | LDBYT<br>LDDT<br>LNML<br>LNMOD<br>LPST0 ~ LPST7<br>LSPIN<br>LSPOT<br>LTSVC                                                                                                                        | Load Byte<br>Load Data<br>Linear Mode Latch<br>Linear Mode<br>Lamp Status 0 ~ 7<br>Low Speed In<br>Low Speed Out<br>Lock to Servo Clock                                                                                                                                                                                                                                                                                                                                                           |
| M | MARSV<br>MCLMP<br>MCPCK<br>MCPSL<br>MLEV<br>MM<br>MM-TP<br>MRTZL<br>MRTZS<br>MS4V<br>MTRSP<br>MUSFM<br>MUSFV<br>MUSFX<br>MVHSL<br>MVINN<br>MVOTG<br>MVOUT<br>M12V<br>M25M<br>M3M<br>M4VDE<br>M5MS | MARS Voltage<br>Minus Clamp<br>Multi Chip Check<br>Multi Chip Select<br>Minus Level<br>Mono-Stable Multivibrator<br>Mono-stable Multivibrator - Test Point<br>Manual Rezero Latch<br>Manual Rezero Switch<br>-4V<br>Motor at Speed<br>MARS Unsafe Movable Head<br>MARS Unsafe Voltage<br>MARS Unsafe Fixed Head<br>Movable Head Select<br>Move Inner<br>Move Out Gate<br>Move Outer<br>-12V<br>Mono-Stable 2.5 Milli-Second<br>Mono-Stable 3 Milli-Second<br>-4V DE<br>Mono-Stable 5 Milli-Second |
| N | N-Q<br>N+Q>0<br>NC1 ~ NC512<br>NGT<br>NOTCH<br>NRMS<br>NSQCH<br>NSQHG                                                                                                                             | Normal Minus Quadrature<br>Normal Plus Quadrature Greater Than Zero<br>New Cylinder Address Register 1 ~ 512<br>Noise Gate<br>Notch Filter<br>Normal Switch<br>Not Squelch<br>Not Squelch Gate                                                                                                                                                                                                                                                                                                    |

|   | Abbreviation                                                                                                                                                                                                 | Full Name                                                                                                                                                                                                                                                                                                                                                                                   |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| O | OCDTA/OCDTB<br>OCDTH/OCDTL<br>OCTCK<br>ODD1 ~ 2<br>OFACT<br>OFCMD<br>OFSET<br>OFINT<br>OFOUT<br>OFTRK<br>ONCYL<br>ONL<br>ONTRK<br>OSC<br>OTENB<br>OVCRT<br>OVCY<br>OVSCK<br>OVSGB                            | Open Cable Detect Channel-A/B<br>Open Cable Detect High/Low<br>Over Cylinder and Control Check<br>Odd 1 ~ 2<br>Offset Active<br>Offset Command<br>Offset<br>Offset Interrupt<br>Offset Out<br>Off Track<br>On Cylinder<br>On Line<br>On Track<br>Oscillator<br>Out Enable<br>Over Current<br>Over Cylinder<br>Over-Shoot Check<br>Over-Shoot Guard Band                                     |
| P | PADRV<br>PCLMP<br>PC1 ~ PC512<br>PICIN<br>PICINB<br>PICOT<br>PLEVL<br>PLOAN<br>PLO1F<br>POSER<br>POSN<br>POSQ<br>POTRL<br>PRTCT<br>PS6V<br>PWORS<br>PWRDY<br>PWRLP<br>PWRST<br>P12V<br>P5V<br>P5VFX<br>P6VMV | Power Amp. Drive<br>Plus Clamp<br>Physical Cylinder Address Register 1 ~ 512<br>Pic-In<br>Pic-In Channel-B<br>Pic-Out<br>Plus Level<br>PLO Analog<br>PLO 1F<br>Position Error<br>Position Normal<br>Position Quadrature<br>Pick Out Relay<br>Protect<br>+6V<br>Power On Reset<br>Power Ready<br>Power Lamp<br>Power On Reset<br>+12V<br>+5V<br>+5V for Fixed Heads<br>+6V for Movable Heads |

|   | Abbreviation  | Full Name                        |
|---|---------------|----------------------------------|
| R | RAWDT         | Raw Read Data                    |
|   | RAW2FA/RAW2FB | Raw 2F A/B                       |
|   | RD            | Read                             |
|   | RDCKH/RDCKL   | Read Clock High/Low              |
|   | RDDGT         | Read Data Gate                   |
|   | RDDT          | Read Data                        |
|   | RDDTA         | Read Data                        |
|   | RDDTA-TP      | Read Data - Test Point           |
|   | RDDTFX        | Read Data Fixed Head             |
|   | RDDTG         | Read Data Gate                   |
|   | RDDTH/RDDTL   | Read Data High/Low               |
|   | RDDTMV        | Read Data Movable Head           |
|   | RDWT          | Read/Write                       |
|   | RDYLP         | Ready Lamp                       |
|   | REGRT         | Register Reset                   |
|   | RGCTL         | Read Gate Control                |
|   | RGDNP         | Read Gate Down Pulse             |
|   | RGUPP         | Read Gate Up Pulse               |
|   | RNTMG         | Run Timer Gate                   |
|   | RNTMR         | Run Timer                        |
|   | RONLY         | Read Only                        |
|   | RRSVA/RRSVB   | Reset Reserve Channel A/B        |
|   | RSKEN         | Reset Seek End                   |
|   | RSSCT         | Reset Index Sector Counter       |
|   | RST           | Reset                            |
|   | RSTMS         | Release Timer Switch             |
|   | RSTSC         | Reset Sector Counter             |
|   | RST1 ~ 2      | Reset 1 ~ 2                      |
|   | RTBTC         | Reset Bit Counter                |
|   | RTFTM         | Reset Track Following Timer      |
|   | RTGDB         | Reset Guard Band                 |
|   | RTZMD         | Rezero Mode                      |
|   | RWCAP         | Read/Write Capable               |
|   | RWDTF         | Read/Write Data for Movable Head |
|   | RWDTFX        | Read/Write Data for Fixed Head   |
|   | RWDTM         | Read/Write Data for Movable Head |
|   | RWDTMV        | Read/Write Data for Movable Head |
|   | RZGH          | Rezero or Go Home                |
|   | RZML          | Rezero Mode Latch                |
|   | RZMOD         | Rezero Mode                      |
|   | RZOUT         | Rezero Out                       |
|   | RZRCM         | Rezero Command                   |
|   | RZRST         | Rezero Start                     |



| S | Abbreviation  | Full Name                    |
|---|---------------|------------------------------|
|   | SAGC          | Servo AGC                    |
|   | SCMPA/SCMPB   | Selecte Compare Channel-A/B  |
|   | SCTCL         | Sector Clock                 |
|   | SCTLX         | Sector Index                 |
|   | SCTP          | Sector Pulse                 |
|   | SCTRH/SCTRL   | Sector High/Low              |
|   | SCTRP         | Sector Pulse                 |
|   | SC1 ~ SC128   | Sector Counter 1 ~ 128       |
|   | SDF16         | Seek Difference 16           |
|   | SHORT         | Short                        |
|   | SKEDA/SKEDB   | Seek End Channel-A/B         |
|   | SKEDH/SKEDL   | Seek End High/Low            |
|   | SKENA/SKENB   | Seek End Channel-A/B         |
|   | SKEND         | Seek End                     |
|   | SKINH         | Seek Inhibit                 |
|   | SLCTD         | Selected                     |
|   | SLIW          | Select I Write               |
|   | SLOW          | Slow                         |
|   | SLTDH/SLTDL   | Selected High/Low            |
|   | SMOTH         | Smoother                     |
|   | SNI           | Select Normal Invert         |
|   | SNN           | Select Normal Non-Invert     |
|   | SOFCK         | Servo Offtrack Check         |
|   | SOFST         | Set Servo Offset             |
|   | SOSCK         | Set Over-Shoot Check         |
|   | SPALM         | Speed Alarm                  |
|   | SPR           | Spare                        |
|   | SPSTT         | Spindle Start                |
|   | SQI           | Select Quadrature Invert     |
|   | SQN           | Select Quadrature Non-Invert |
|   | SQRZR         | Sequence Rezero              |
|   | SRVL          | Servo Latch                  |
|   | SRO ~ SR3     | Shift Register 0 ~ 3         |
|   | SST           | Seek Start                   |
|   | START         | Start                        |
|   | STMD1 ~ 2     | Status Mode 1 ~ 2            |
|   | STRSW         | Start Switch                 |
|   | STRTL         | Start Latch                  |
|   | STRZ          | Start Rezero                 |
|   | STSOF         | Set Servo Offtrack Check     |
|   | STS0 ~ STS7   | Status 0 ~ 7                 |
|   | STSOB ~ STS7B | Status 0 ~ 7 Channel B       |
|   | STSOH ~ STS7H | Status 0 ~ 7 High            |
|   | STSOL ~ STS7L | Status 0 ~ 7 Low             |
|   | STTLP         | Start Lamp                   |
|   | STTMR         | Start Timer                  |
|   | STTOK         | Start OK                     |
|   | STTRL         | Start Relay                  |
|   | STTSW         | Start Switch                 |
|   | STUSO         | Status 0                     |
|   | STWAT         | Set Wait                     |
|   | SVLVL         | Servo Level                  |

|   | Abbreviation                                                                                                                                                                                                                                     | Full Name                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| S | SVMDG<br>SVMDP<br>SVMOD<br>SVOFT<br>SVPRE<br>SYNCG<br>SYSRZ<br>S1 ~ S16384                                                                                                                                                                       | Servo Mode Gate<br>Servo Mode Pulse<br>Servo Mode<br>Servo Off-Track<br>Servo Pre-Amp.<br>Sync. Gate<br>System Rezero<br>Sector Switch 1 ~ 16384                                                                                                                                                                                                                                                                            |
| T | TAG1 ~ TAG5<br>TAG1A ~ TAG5A<br>TAG1B ~ TAG5B<br>TAG1C<br>TAG1H ~ TAG5H<br>TAG1L ~ TAG5L<br>TFTMR<br>TIEDN<br>TIEUP<br>TIEUP1 ~ 2<br>TKXGP<br>TKXNG<br>TMGT<br>TMOCK<br>TMOFF<br>TMON<br>TMOTL<br>TMOUT<br>TRMWD<br>TRSCK<br>TRWD<br>T3M<br>T5MS | Tag 1 ~ 5<br>Tag 1 ~ 5 Channel-A<br>Tag 1 ~ 5 Channel-B<br>Tag 1 C<br>Tag 1 ~ 5 High<br>Tag 1 ~ 5 Low<br>Track Following Timer<br>Tie-Down<br>Tie-Up<br>Tie-Up 1 ~ 2<br>Track Crossing Pulse<br>Track Crossing<br>Timer Gate<br>Time Out Check<br>Timer Off<br>Timer On<br>Time Out Latch<br>Time Out<br>Transmit Write Data<br>Transition Check<br>Transmit Write Data<br>Trigger 3 Milli-Second<br>Trigger 5 Milli-Second |
| U | UAD1 ~ UAD4<br>USLTD<br>USL1A ~ USL4A<br>USL1B ~ USL4B<br>USL1H ~ USL4H<br>USL1L ~ USL4L<br>USTGA/USTGB<br>USTGH/USTGL                                                                                                                           | Unit Address 1 ~ 4<br>Unit Selected<br>Unit Select Bit 1 ~ 4 Channel-A<br>Unit Select Bit 1 ~ 4 Channel-B<br>Unit Select Bit 1 ~ 4 High<br>Unit Select Bit 1 ~ 4 Low<br>Unit Select Tag Channel A/B<br>Unit Select Tag High/Low                                                                                                                                                                                             |

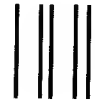
|   | Abbreviation  | Full Name                           |
|---|---------------|-------------------------------------|
| V | VCMA/VCMB     | Voice Coil Motor A/B                |
|   | VCOC1 ~ VCOC4 | VCO Counter 1 ~ 4                   |
|   | VC01F/VC02F   | VCO 1F/2F                           |
|   | VCX           | Voltage Control Signal              |
|   | VCX-TP        | Voltage Control Signal - Test Point |
|   | VC01/VC02     | Voltage Controlled Oscillator 1/2   |
|   | VFOFS         | VFO Fast Sync                       |
|   | VFO1F         | VFO 1F                              |
|   | VFO1S         | VFO 1 Shifted Clock                 |
|   | VFS           | VFO Fast                            |
|   | VG20I         | Velocity Greater Than 20 Inch/Sec   |
|   | VLERR         | Velocity Error                      |
|   | VLGDA         | Velocity Guide                      |
|   | VLIX1         | Valid Index 1                       |
|   | VLSIT         | Velocity                            |
|   | VLTY          | Velocity                            |
| W | WATL          | Wait Latch                          |
|   | WATST         | Wait Set                            |
|   | WDATA         | Write Data                          |
|   | WDATA-TP      | Write Data - Test Point             |
|   | WGCTL         | Write Gate Control                  |
|   | WGSL          | Write Gate Selected                 |
|   | WIRCK         | Write Current On Read Check         |
|   | WSLFX         | Write Select Fixed Head             |
|   | WSLMV         | Write Select Movable Head           |
|   | WT            | Write                               |
|   | WTCA/WTCB     | Write Clock Channel-A/B             |
|   | WTCK          | Write Clock                         |
|   | WTCKA/WTCKB   | Write Clock Channel-A/B             |
|   | WTCKH/WTCKL   | Write Clock High/Low                |
|   | WTCL          | Write Clock                         |
|   | WTCR          | Write Current                       |
|   | WTCRF         | Write Current Fixed Head            |
|   | WTCRM         | Write Current Movable Head          |
|   | WTDI          | Write Data                          |
|   | WDTA/WDTB     | Write Data Channel-A/B              |
|   | WTDTH/WDTL    | Write Data High/Low                 |

|   | Abbreviation                                                                                                                                               | Full Name                                                                                                                                                                                                                                                                                                                                         |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Z | ZRACM<br>ZRMOD<br>ZRX<br>ZRX-TP<br>1 ~ 16384<br>1FCKH/1FCKL<br>1FMCL<br>1FWCK<br>1FWCL<br>1FWWD<br>11S60<br>2FEY1/2FEY2<br>2FLT<br>2FMCL<br>2FOT<br>2FRDCL | Difference Zero Access Mode<br>Zero Mode<br>Zero Cross Data<br>Zero Cross - Test Point<br>Sector Switch Input 1 ~ 16384<br>1F Write Clock High/Low<br>1F Main Clock<br>1F Write Clock<br>1F Write Clock<br>1F Write Window<br>11 Second or 60 Second<br>2F Early Clock 1/2<br>2F Late Clock<br>2F Main Clock<br>2F On Time Clock<br>2F Read Clock |
|   | -S4V<br>-S4VRTN<br>- VLTY <br>-4VDE<br>-5.2V-TP<br>-5.2VE<br>+S6V<br>+S6VRTN<br>+48VRTN<br>+5VFX<br>+6VE<br>+6VFX<br>+6VMV                                 | Servo -4 Volt<br>Servo -4 Volt Return<br>Negated Absolute Velocity<br>-4 Volt to DE<br>-5.2 Volt - Test Point<br>-5.2 Volt<br>Servo +6 Volt<br>Servo +6 Volt Return<br>+48 Volt Return<br>+5 Volt to Fixed Head<br>+6 Volt<br>+6 Volt to Fixed Head<br>+6 Volt to Movable Head                                                                    |



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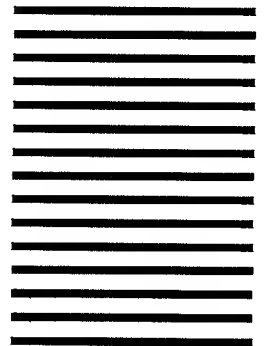
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